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ART. XXVIII.—*Some Remarks in regard to the Period of Elevation of those ranges of the Rocky Mountains, near the sources of the Missouri River and its Tributaries;* by Dr. F. V. HAYDEN.*

[Abstracted from Capt. WM. F. RAYNOLD'S forthcoming Report and published by permission of the War Department.]

THE object of the present article, is to show, as nearly as can be done from known geological data, the period of the elevation of a portion of the Rocky Mountains. My observations have been more especially confined to the ranges from which the Missouri and Yellow Stone Rivers, with their numerous tributaries take their rise, though I feel confident that principles which will apply to mountains occupying so large an area will also be applicable to the whole Rocky Mountain district. It will be impossible, at this time, to mention in detail all the facts in support of my statements, and therefore I shall assume that the reader has examined the previous papers of my associate, Mr. Meek, and myself. During the coming year I hope to prepare a series of articles for this Journal which will have a more or less direct bearing on the physical geography of this region and the influ-

* For most important information I would direct attention to Second Series of this Journal, Articles xiii, xxxix, vol. iii, 1847, Art. xxxiv, vol. xii, 1849, and Arts. xxiv, xxv, vol. xxii, 1856, by Prof. J. D. Dana, in which, it seems to me, will be found the most profound, far-reaching generalizations in regard to the physical geography and geology of the West and other portions of our country, which have ever been given to the public. The origin and character of those subterranean forces which have produced such important results in the West are fully discussed in those papers.

ences which gave to it, its present configuration. Some erroneous statements, growing out of our limited knowledge of the structure of these mountain chains, may be made, but these when known, will be corrected. Geology is a progressive science and even our best efforts are but approximations to truth rather than the truth itself.

The evidence seems to me to be clear that the great subterranean forces that elevated the western portion of our continent were called into operation toward the close of the Cretaceous epoch, and that the gradual quiet rising continued, without a general bursting of the earth's crust until after the accumulation of the Tertiary lignite deposits or at least the greater part of them; also that after the fracture of the surface commenced and those great crust movements began to display themselves, the whole country continued rising, or at least, though there may have been periods of subsidence or repose, there was a general upward tendency which has continued even up to our present period. I hope hereafter to illustrate the correctness of these statements by all the facts that have been obtained in my past explorations as well as by those I may secure in the future.

Let us, in the first place, examine some of the barometrical profiles across the country from the Mississippi river to the Pacific coast, constructed under the direction of the War Department. Previously, however, to this examination we may make the statement that west of long. 98° the surface of the country may be separated into two divisions, mountain and plain, and that a combination of the two compose the Rocky Mountain district. After leaving the Mississippi the intervening country westward to the upheaved ridges is an apparently level or undulating plain, with no disturbance of the strata of the underlying formations until we come in close proximity to some of the mountain elevations. Reaching the base of the elevated ridges which form the mountain crests, we at once commence a rugged and abrupt ascent.

If we look at the profile constructed by Gov. Stevens, from St. Paul, Minnesota, lat. 44° 58′ and lon. 92° 58′ to the Pacific coast we shall find that the starting point is 828 feet above the ocean level. Near Fort Union, at the junction of the waters of the Yellow Stone and Missouri, 670 miles westward, the height above the ocean level has increased to 2010 feet, or 1182 feet higher than St. Paul. We thus see that the average ascent of the country between these two points is not quite two feet to the mile. From Fort Union to the Valley of Dearborn river, just under the base of the elevated ridges of the principal eastern range, we find the distance to be 448 miles and the height above the ocean 2081 feet greater than that at Fort Union, or the average rate of ascent increased to nearly five feet per mile. Over

this vast extent of country, extends an almost limitless prairie, apparently level, with no forests or groves, with no timber except that which skirts the streams. There is in this great distance, a gradual increase in the inclination of the strata proportioned to the increase of the ascent, but no marked disturbance of the beds until we arrive in close proximity to the mountain elevations. There are a few local fractures of the earth's crust, caused by the elevation of the Bear's Paw, Little Rocky Mountain, &c., around which the sedimentary rocks are more or less disturbed, but all these lesser mountains are more or less remotely connected with the main chain. After passing the highest point of the principal range, along this line, which is near Cadotte's Pass, we commence our descent toward the Pacific very much as we ascended the eastern slope, but over a much more rugged route. We find a continued series of more or less parallel ridges of elevation until we approach the coast for a distance of from 400 to 600 miles. From Fort Walla Walla to the ocean however, the average descent is a little less than one foot to the mile.

Again, if we examine the profile constructed by Fremont, commencing at the mouth of the Kanzas river, we find that the initial point is 690 feet above the ocean. Proceeding westward, the average grade for the first three hundred miles is between four and five feet per mile. Thence to Fort Laramie the ascent, as stated by Fremont, is 8 feet to the mile, and from Fort Laramie to Hot Spring Gate although still passing over prairie country the average grade of ascent is given by the same explorer, as 45 feet per mile. Over this entire route, however, loaded wagons have been transported with ease. When we reach the foot of the mountains in this direction, the lofty elevated ridges seem to rise abruptly out of the prairie, averaging from one to six thousand feet in height above the surrounding country. From thence to the Pacific coast we pass over a continued series of elevations which taken in the aggregate seem to trend nearly northwest and southeast, but which when examined in detail, often present no definite direction or continuous line of fracture. This mountain region is composed of a series of these ridges forming a belt or zone, 400 to 800 miles in width from east to west, interspersed with beautiful valleys through which wind streams of clear water. So numerous are the profiles which have now been made across the continent by different explorers that it is hardly necessary to describe each one, since what we have already said indicates the object in view.

We have said that the western portion of our continent, especially if we look only at the easterly slope may very properly be divided into mountain and prairie. It is true that in Kansas and Iowa groves of timber of considerable size are seen, but they form rather the exception than the rule. Along the eastern slope

there is a belt of country 300 to 600 miles in width, where, for the most part the only timber to be seen, is a thin fringe bordering the streams. Even in the eastern portion of the main range, the timber is not luxuriant, like that so common along the coast of Oregon and California. The pine trees are seldom more than three feet in diameter.

Again, we may divide the mountains or elevated ridges which form the different ranges into two kinds; viz., those with long extended lines of fracture, with a granitic nucleus and a comparatively regular outline, and those which appear to be composed of a series of cones or peaks more or less intimately connected, exceedingly irregular in their outline and of eruptive origin. Of the first class, the Black Hills, Big Horn, Laramie and Wind River mountains are good examples, while the Wahsatch, Green River, Jeton ranges and many others west of the dividing crest might be cited as illustrations of the second class. From all the information within our reach we have inferred that after passing the eastern slope the mountain ranges of eruptive origin are far the most numerous. We also know from personal observation that the main range of the Rocky mountains and the subordinate ridges on either side, near the head waters of the two principal branches, the Yellow Stone and Missouri, are of similar origin and present similar rugged features.

We may now return to the Cretaceous period. In a previous paper in this Journal,* we remarked that there were no indications in the geological formations of that portion of the West over which we have traversed of long continued deep water deposits, until we pass up into the Cretaceous epoch. The lower portion of No. 1, or the Dakota group, which ushered in the Cretaceous epoch in this portion of the West, is composed of coarse sand, pebbles, &c., with ripple marks, oblique laminæ, and with other indications of shallow water and change of currents. The same characters are seen throughout the formation wherever it is exhibited. We also know from the numerous impressions of leaves, and some beds of impure lignite, that dry land could not have been far distant. But as we pass up through Nos. 2, 3 and 4, whatever changes of land may have occurred in the meantime, we think there were periods at least when the sea was of considerable depth and suffered a quiet deposition to go on. We infer this from the fine and homogeneous character of the sediments. Throughout No. 4 we have a fine plastic clay which continues up into No. 5, when a gradual change takes place from the introduction of yellowish ferruginous matter, and a slow increase of sandy sediments. Toward the middle of No. 5, the sand begins to predominate until the upper part becomes a

* Vol. xxxi, March, 1861.

coarse, ferruginous sandstone, with all the indications of shallow water deposits. We know also, from fragments of wood and impressions of leaves which have been found quite widely distributed in the upper part of No. 5, that dry land could not have been far away. We also infer from the character of the Molluscan remains that the great Cretaceous sea which had so long spread its vast waters over this region was becoming shallow, and that a new epoch was approaching. As we arise in No. 4, and pass up into No. 5, there is an evident increase in the number of Gasteropoda indicating shoal waters. We have already remarked their peculiar Tertiary aspect, which seemed to point directly to that epoch, showing that it was not far distant. We may now ask the cause of this apparent approach to land, as foreshadowed by the lithological as well as the palæontological characters of the Upper Cretaceous formation No. 5. We think that the facts indicate that during the deposition of this formation the western portion of the continent was slowly rising above the ocean level, the waters on the one side receding toward the Pacific, and on the other toward the Atlantic, introducing the great Tertiary epoch which had already been foretold in the Cretaceous. At the commencement of the Tertiary period, throughout the central portions of the continent, lakes, estuaries, &c., more or less salt, at length becoming brackish, and finally fresh water, existed, and a new flora and fauna were introduced. The subterranean expansive power which was quietly lifting up the country still continued, although no bursting of the earth's crust had commenced. These brackish water deposits which appear to mark the dawn of the Tertiary period in the West, are distributed quite widely over the central portions of the Rocky mountain district and then by a general subsidence or a vast increase of fresh water, the true lignite deposits spread themselves over large areas and probably covered much of the country, now occupied by the mountain ranges and were doubtless more or less intimately connected with the Tertiary beds on the Pacific coast. What barriers separated them from the Tertiary formations along the Pacific—it is impossible from our present limited knowledge of the geology of the intermediate region, to determine.

We have remarked that the probable period of the bursting of the earth's crust which resulted in the formation of those abrupt mountain crests or ridges, occurred somewhere near the close of the accumulation of the true lignite deposits. We believe this for the following reasons. Whenever we observe the lignite beds in the vicinity of the mountain ranges we find them more or less inclined, in the same direction with the older fossiliferous rocks, though, as a general rule, dipping at a smaller angle, because more remote from the axis of the disturbing power.

Of course, as the land was slowly elevated toward the surface of the waters, the newer Tertiary beds would be subjected to the erosive action of water first, and thus continuing downward, as the mass was slowly rising, until the granitic nucleus was exposed. The Tertiary rocks, being composed for the most part of loose, yielding material, sands, clays and lignites, would be worn away from the surface for some distance from the axis of elevation. Although the lignite Tertiary beds are developed in full force all along the base of the larger ranges of mountains, it is not unlikely that some of these ridges formed barriers or lofty shores to these great Tertiary lakes. It would seem as if this country during the Tertiary period was not unlike the Undine region of the north, so called by the geographer Nicollet on account of the great number of fresh water lakes distributed over that district.

Near the Black Hills these beds are worn away from the immediate base of the mountains and it is doubtful from any proofs that we can now obtain whether the Tertiary lake extended over the country at that time occupied by the Black Hills. West of this range, the lignite Tertiary beds incline from the western slope 5 to 10 degrees. All along the Big Horn mountains, the same features, only more strongly marked, are seen. These beds often lie quite high upon the slopes of the mountains conforming to the Cretaceous rocks and sometimes inclining at a high angle. Between the western extremity of the Big Horn range and the Sweet Water mountains on the North Platte they are more disturbed than at any other locality. The lignite Tertiary strata are nearly vertical and the hard layers of sandstone or limestone extend in long projecting lines across the country, while the intermediate yielding beds of clay, sand, and lignite, are smoothed and leveled by atmospheric agencies and clothed with a thick turf of grass. All along the Laramie range, from the Red Buttes to Deer Creek, until the lignite beds are concealed by the White River group, the same features are seen, though the strata incline less, being more remote from the anticlinal crest. On both sides of the Wind River mountains the same phenomena occur, and other examples might be cited pointing to the same conclusions, but enough has been said to show that it is probable that the lignite Tertiary beds partook of the same movements that have elevated the older fossiliferous rocks. We therefore infer that the fracture of the earth's crust in this portion of the West, by which the nucleus of the mountains was revealed, occurred near the time of the accumulation of the lignite deposits or at the close of that epoch.

Again, although there is not a strict unconformability between the true lignite beds and the Wind River group, the latter incline in the same direction only at a much smaller angle. Near

the source of Wind river, the Wind river group rests directly upon Cretaceous formation No. 2. At this point the Cretaceous rocks incline from 10° to 25° while the Wind river beds dip from 1° to 5°. As we ascend the valley of Wind river, towards its source, we pass, for a long distance, the steeply inclined Cretaceous and Jurassic rocks along the margins of the mountains on our left hand, while on our right, but a few hundred yards distant, the naked, almost vertical walls of the lower portion of the Wind river group are seen, the strata however seldom inclining more than one degree.

The same examples may be observed on the west side of the Wind River mountains, where the Wind River beds lie high upon the sides of the western slope in a very slightly inclined position and in some localities covering the very summit, showing clearly that even the dividing crest of the mountains was beneath the waters during the deposition of this group. Along the margins of both the Wind River and the Big Horn mountains these beds seem to have risen undisturbed or in a nearly horizontal condition. We have already expressed the opinion in a previous paper,* that the Wind River group was intermediate in age between the lignite Tertiary and the White River beds, and in point of time filled up a chronological chasm. We have inferred this from the fact that these beds seem to possess palæontological and lithological characters intermediate between the two. They contain casts of a species of *Vivipara* which is undistinguishable from *V. trochiformis* and fragments of a *Trionyx* apparently the same with that occurring in the lignite beds, also fragments of a *Testudo* which, so far as we can determine, is identical with the *T. Nebrascensis* of the White River beds. If we look also at the composition of the Wind River beds, we find that their light color, indurated arenaceous and argillaceous character, and their general appearance after erosion favors the correctness of the inference in regard to their intermediate position. From the facts before us in regard to this group, we conclude that even after the crust broke, the country continued slowly rising while the Wind River deposits were accumulating, and that the upper portions when not eroded away were elevated high upon the sides of the mountains in a nearly horizontal position.

Again, the White River beds hold a similar position with reference to the lignite formations as the Wind River group. They are seldom disturbed, and only in a few instances do they incline as much as 5°. They however occur high upon the mountain slopes along both sides of the Laramie range, showing that they partook of the gradual elevation of the country, after the crust was broken and the mountain district began to approach its present configuration. On the west side of the Black Hills,

* See this Journal, vol. xxxi, March, 1861.

where the White River beds probably began their origin, we find only the lower strata of this group, usually reposing directly upon Cretaceous rocks, though in a few localities upon lignite formations. But as we descend south and southwestward these lower beds disappear and more recent ones take their place, until they pass into the Pliocene sands of the Loup River group, and then in turn, still farther southward, are lost in the Loess or yellow marl deposits. We can only account for these phenomena on the supposition that this great Tertiary fresh water lake had its commencement in the White River valley, and as the Black Hills, and of course the whole Rocky Mountain district, arose slowly towards its present elevation, the waters gradually receded southward and southwestward, and then more recent beds continued to be accumulated, until this formation spread itself over the vast area which it now occupies. We thus think that, by means of these Cretaceous and Tertiary deposits of the West, we can yet trace step by step the progress of that grand development which has given the present geographical conformation to the West, and originated the fountains from which flow those mighty rivers which may well be called the commercial arteries of the American continent.

Another illustration of the gradual and long continued rise of the country may be found in the immense chasms or cañons which have been formed by the streams along the mountain sides. We can only account for them on the supposition that as the anticlinal crest was slowly emerging from the sea, the myriad sources of our great rivers were seeking their natural channels, and that these branches or tributaries began this erosive action long before the great thoroughfares, the valleys of the Mississippi and the Missouri, were marked out. The erosion would go on as the mountains continued slowly rising at an almost imperceptible rate, and in process of time the stupendous channels which everywhere meet us along the immediate sides of the mountains would be formed. If we examine the barometrical profiles, already referred to, we see at a glance that in traversing the country from the Mississippi to the foot of the mountains the ascent is very gradual, but increases as we approach the upheaved ridges. In an equal proportion will the rapidity and consequently the erosive power of the streams be increased so that we may readily account for those grand displays of the erosive action of water which occur so frequently along the mountain sides. Eastward from the mountains, beyond this immediate influence, the descent is so gradual that the Missouri flows quietly along over its yielding alluvial bed, transporting its sediments to the Gulf of Mexico.

That the progressive elevation of the country continued up to our present period or at least until near the time of the deposi-

tion of the most recent superficial deposits, we think we have evidence derived from the terraces, which are seen all along the streams. The elevation of these terraces increases as we approach the sources of the rivers, averaging from a few feet to 150 or 200 feet in height. This subject will be discussed more fully in a future article.

We conclude therefore that the barometrical profiles, constructed from explorations across our continent, and geological data, indicate a long continued quiet expansion of the earth's crust, commencing toward the close of the Cretaceous epoch and extending even to our present period; that near the close of the accumulation of the Tertiary lignite deposits the crust of the earth had reached its utmost tension, the long lines of fractures had commenced, and the anticlinal crests of the mountain ranges were marked out. In a previous paper in this Journal, we remarked that there is no unconformability in any of the fossiliferous sedimentary strata in the northwest, from the Potsdam sandstone to the summits of the true lignite Tertiary. We believe therefore that the elevated ridges which form the nuclei of the mountain ranges began to emerge above the surface of the surrounding country near the close of the Eocene period. We think also that the evidence is clear that there were periods of subsidence and repose, but the thought which we wish to illustrate is, that there was a slow, long continued, quiet, upward tendency which began near the close of the Cretaceous epoch and culminated in the present configuration of the western portion of our continent near the commencement of our present period.

Smithsonian Institution, Washington, D. C., Jan. 1st, 1862.

ART. XXIX.—*Contributions from the Sheffield Scientific School of Yale College*—*II. *On the Chemical Constitution of the Wax of the Myrica cerifera;* by GIDEON E. MOORE, B.P.

THE fruit of the Myrica cerifera yields a wax which for many years has constituted, to a limited extent, an article of commerce in the United States under the names of Myrtle-wax, Candleberry wax and Bay-berry Tallow. It occurs abundantly as a white incrustation on the small globular nuts of the plant. To prepare it in a nearly pure state, the berries are enclosed in bags of coarse cloth and kept immersed in boiling water until the fused wax collects on the surface, it is then poured off into pans in which it solidifies on cooling—in this form and without further preparation it is brought into commerce. It is employed in its

* Communicated by Profs. Johnson and Brush.

pure state as a polish to diminish the friction between surfaces of wood moving in mutual contact, and in admixture with other fatty bodies as a substitute for bees-wax in the manufacture of candles. It is also used in polishing furniture and enjoys some popular repute as a remedial agent.

We are indebted for the first published account of this substance to Alexandre,* Surgeon, correspondent of M. de Mairan, who mentions a wax obtained in Louisiana from the fruit of a tree about the size of a cherry tree and resembling myrtle in appearance, which he states to have been employed by the colonists in the manufacture of candles. Mr. Alexandre likewise states that the water in which the berries have been boiled, when evaporated to the consistence of an extract, is a certain cure for the most violent cases of dysentery.

At a later period accounts of the tree or shrub were given by Marshal, Lepage-Duprat, and by Toscan, Librarian at the Museum of Natural History at Paris. The latter in a memoir in his work entitled *L'Ami de la Nature* gave a circumstantial description of the mode of collecting the wax in early colonial times.†

The traveller, Kalm, speaking of myrtle wax says "in the country where it grows they make excellent soap of it which washes linen perfectly white."

The first attempt to investigate the chemical composition of this substance was made by the Danish chemist, Dr. John,‡ in the early part of the present century. By treating the wax from the *M. cerifera* with boiling alcohol, this observer separated it into two portions. To the soluble portion he gave the name of

* Histoire de l'Academie, Ann. 1722 and 1725—pp. 11 and 39.

† "Towards the end of autumn when the berries are ripe, a man leaves his house, together with his family, to go to some island or bank near the sea shore where the wax trees grow in abundance. He carries with him vessels to boil the berries, and a hatchet to build a cottage where he may find shelter during his residence in this place, which is usually three or four weeks. While he cuts down trees his children gather the berries. A very fertile shrub will afford nearly seven pounds. When these are gathered the whole family employ themselves in procuring the wax. They throw a certain quantity of the berries into the kettle, and then pour a sufficient quantity of water on them so as to cover them to the depth of about half a foot. They then boil the whole, stirring the grains about and rubbing them against the sides of the vessel in order that the wax may more easily come off. In a short time it floats on the water like fat, and is collected with a spoon and strained through a course cloth to separate it from any impurities which might be mixed with it. When no more wax can be obtained they take the berries out with a skimmer and put others into the same water, but it must be entirely changed the second or third time, and in the meantime boiling water must be added as it evaporates in order to avoid retarding the operation. When a considerable quantity of wax has been obtained by this means, it is laid on a cloth to drain off the water with which it is still mixed. It is then melted a second time, and it is then formed into masses. Four pounds of berries yield about one of wax; that which is first obtained is generally yellow; but in later boilings it assumes a green color from the pellicle with which the kernel of the berry is covered."—*Translation in Nicholson's Journal*, vol. iv, p. 189.

‡ Chemische Untersuchungen, iii, 38.

cerin and to the insoluble that of *myricin*, from the specific and generic names of the plant. Subsequently discovering as he supposed two identical substances in bees-wax he conferred upon them the same names, which are even still in use.

In the year 1802 Mr. C. L. Cadet* gave an account of the myrtle berry and the mode of culture, with experiments on the solubility of the wax in various menstrua, and mentioned that it saponified readily with the alkalies.

A few months later, Dr. John Bostock† gave an accurate description of the physical properties of the wax, its comportment towards solvents and alkalies, and concluded by stating the affinity of myrtle wax to the fixed oils—at the same time giving it as his opinion that the vegetable waxes bear the same relation to the fixed oils of plants that the resins do to the essential oils, i. e., are derived from them by the process of oxydation.

Besides these early imperfect notices of the myrica wax, we have more recently, an elementary analysis by Lewy who found its composition as follows:‡

Carbon,	74·00
Hydrogen,	12·00
Oxygen,	14·00
	100·00

Chevreul also examined the myrica wax. According to him it is completely saponified by potash-lye and yields in the operation besides glycerine, stearic, margaric and oleic acids.§ As will appear in the sequel, this distinguished chemist must have operated on an adulterated specimen.

The wax employed in the following research was the commercial article as found in the drug stores of New Haven, and was collected in the vicinity of this place. To the kindness of Mr. E. W. Blake, Jr., I am indebted for a small specimen prepared by himself from berries gathered in Rhode Island, this enabled me to test the purity of the commercial wax. The latter though procured at different times from several sources, in no case appeared to have been adulterated, as shown by the uniform fusing point of the wax itself, and of the mixed fatty acids resulting from its saponification.

The wax, as existing in commerce, is of various shades of color, from greyish-yellow, nearly destitute of any other tint, to a rich deep green, due to chlorophyll; the odor is balsamic and slightly aromatic, much more powerful however in the dark than in the light colored varieties. These differences in appearance and odor are not connected with any material variation in the other physical properties, such as specific gravity and fusion point, which remain nearly constant throughout.

* Annales de Chimie, xliv, 140.
† Nicholson's Journal, iv, 130.
‡ Handwörterbuch der Chemie, v, 413.
§ *Loc. cit.*

The specific gravity of myrtle-wax ranges from 1·004 to 1·006 and the point of fusion from 47° to 49° C. Its hardness and brittleness are much greater than those of beeswax. According to Dr. Bostock one hundred parts by weight of boiling alcohol dissolve five parts of the wax, four-fifths being deposited on cooling and one-fifth remaining suspended in the fluid but gradually depositing after a few days, or it may be precipitated at once by the addition of water. Only four-fifths of the wax are dissolved by hot alcohol, the remainder being totally unacted on even by prolonged digestion with fresh quantities of the solvent. Boiling ether, according to the same author, dissolves more than one-quarter of its weight of the wax, of which, the greater part separates on cooling. At a moderate heat it is also taken up by oil of turpentine to the extent of six per cent.

With a solution of caustic potash, myrtle wax saponifies readily, giving a fragrant soap which is freely soluble in water and which by decomposition with sulphuric acid yields a mixture of fatty acids fusing at 61° C., and readily soluble in hot alcohol. From this solution it may be wholly precipitated by an alcoholic solution of acetate of lead. Upon washing and drying the precipitate, and digesting it for several days at a moderate temperature with twice its bulk of ether, a waxy substance was dissolved which did not blacken by sulphid of ammonium and left no residue upon ignition, thus proving the absence of oleic acid. The portion dissolved by ether consisted of unsaponified wax which being suspended in the solution of soap in a state of fine division escaped detection, was carried down mechanically in the precipitate produced by acids, thrown down a second time in the precipitate by acetate of lead and was afterwards dissolved out by the ether.

A portion of the wax was saponified with litharge and the lead soap repeatedly washed with water. Upon evaporation of the washings in vacuo, a viscid fluid was obtained possessing the sweet taste and other characteristic properties of glycerine, the quantity obtained was, however, quite small in proportion to the amount of wax employed.

About two pounds of the wax were then saponified with caustic potash and the soap decomposed by sulphuric acid, the precipitate was fused and agitated repeatedly in contact with renewed portions of distilled water and finally dried. It possessed a fusing point of 60° C. A portion of this substance was introduced with a considerable quantity of distilled water into a capacious retort and subjected to distillation; after about one-half of the water in the retort had passed over, the distillate was found to contain a few globules of fused fat floating on its surface—these were collected and their fusing point taken—it was found to be identical with that of the substance previous to distillation,

thus proving conclusively the absence of the more volatile fatty acids.

One hundred grammes were taken, and after solution in alcohol, were subjected to fractional precipitation, the method originally proposed by Heintz* being employed under the following modification. The alcoholic solution of the fatty acids was made of such strength that the degree of saturation at which a precipitate separated on cooling to the ordinary temperature of the atmosphere, was almost, but not quite attained. The solution was measured and one-tenth part was poured into another vessel, this portion was then precipitated as accurately as possible by a saturated alcoholic solution of acetate of lead. The precipitate together with the fluid in which it was suspended was now poured back into the remaining portion of the solution, and the whole heated to ebullition and maintained at that temperature until the precipitated lead salt was redissolved and the fluid was brought to nine-tenths of its original bulk. The whole was then set aside to cool, by which the precipitate was a second time thrown down. This precipitate was collected on a filter and dried, as the *first fraction*. A portion of the filtrate equal to that first taken was now precipitated accurately with acetate of lead, the precipitate with the fluid in which it was suspended was poured back into the rest of the solution, the whole heated and evaporated until brought to eight-tenths of its original bulk, and after cooling, the precipitate collected and dried as the *second fraction*. This operation was repeated until *nine fractions* in all had been obtained, the fluid to be precipitated occupying successively, $\frac{9}{10}$, $\frac{8}{10}$, $\frac{7}{10}$, $\frac{6}{10}$, $\frac{5}{10}$, $\frac{4}{10}$, $\frac{3}{10}$, $\frac{2}{10}$, and $\frac{1}{10}$, of its original bulk. The last portion of fluid containing the *tenth fraction* gave no precipitate with acetate of lead, and upon examination was found to contain the ethylic ethers of the fatty acids with but very little free acids.

Of the fractional precipitates thus obtained, the 1st, 2d, 3d, 7th, and 9th were further examined. They were decomposed by repeated boiling with moderately dilute hydrochloric acid and the fatty acids thus separated were thoroughly washed by hot water. The fusing points of these products were as follows, respectively:

1st fraction, 60·5° C., 2d, 61·°, 3d, 61·°, 7th, 55·°, 9th, 50.° The 10th fraction which gave no precipitate with acetate of lead remained fluid at 20·° C.

The fact that by long boiling the mixed fatty acids with water, a distillate was obtained which had the same fusing point as the original mixture, together with the narrow range of fusing points among the fractions first examined, made it appear unnecessary to study the others.

* Jour. für Prakt. Chem., lxvi, 1.

The products obtained from each of the above mentioned lead precipitates were severally subjected to repeated crystallization from alcohol until the fusing point of the crystals stood unaltered by further treatment. From each fraction an acid was thus procured which fused at 62° C., and agreed in all respects with *palmitic acid.* The first three fractions consisted almost entirely of this substance and it was present in considerable quantity even in the ninth fraction.

The filtrates from the crystallization of the 7th and 9th fractions were then mixed and subjected to recrystallization. A crop of crystals thus obtained likewise fused at 62° C. The new filtrates were then mingled and crystallized again with the same results.

The concentrated mother liquors from which nearly all the palmitic acid had thus been separated, were now evaporated nearly to dryness, and the mass saponified to destroy the ethers formed by prolonged contact with alcohol. The soap was decomposed by acids, the precipitate dissolved in alcohol, the fluid evaporated until a slight crop of crystals formed on cooling; the fluid poured off from these was again evaporated until a deposit ensued on cooling, and this process was repeated until the crystals thus formed exhibited a constant fusing point, viz. 43° C. It thus appears that *lauric acid* is an ingredient of this wax. The 10th fraction which was fluid at ordinary temperatures was found by similar treatment to consist almost entirely of *lauric ether* formed by prolonged contact with alcohol.

About one pound of the crude fatty acids was repeatedly agitated with small quantities of boiling alcohol until the fusing point of the portion undissolved, remained constant at 62° C. The several alcoholic solutions thus obtained were then mixed and evaporated to the point at which crystals formed on cooling, the whole allowed to cool to the ordinary atmospheric temperature, the crystals thus formed removed, and the process repeated several times, by which means a still further portion of the least soluble substance was removed. The fluid filtered from the crystals was now treated with caustic potash and after addition of water the whole was heated until no more alcohol could be expelled. The precipitate obtained by treating this solution with sulphuric acid, was dissolved in alcohol and subjected to a fractional crystallization to remove palmitic acid, by which means a sufficient quantity of the substance fusing at 43° C. was obtained for an elementary analysis.

The two substances thus obtained and which from their fusing points and other characteristic properties were pronounced to be respectively palmitic and lauric acids, were further purified by solution in alcohol, decolorization by animal charcoal, resaponification, decomposition of the soaps by acids, and careful washing

with distilled water, by which means they were obtained in a state of nearly absolute purity.

The above operations were very much complicated by the fact of the strong tendency of lauric acid to form an ether when left for any length of time in contact with alcohol. In this respect it far surpasses palmitic acid. A mixture of these two acids in which there was a great preponderance of the latter, was digested for several days in alcohol at the ordinary temperature of the atmosphere. Upon adding a weak solution of potash to remove uncombined acid, and finally washing with water—an oily fluid was obtained which became solid by a very slight decrease in temperature, and which upon examination turned out to consist of nearly pure laurate of oxyd of ethyl. This ether could only be decomposed by prolonged digestion at a moderate heat with a very concentrated solution of fixed caustic alkali.

The palmitic and lauric acids obtained in the preceding operations were subjected to combustion with oxyd of copper and oxygen gas, with the following results:

0·1967 grms. palmitic acid gave 0·54 grms. carbonic acid and 0·228 grms. water.

		Theory.	Experiment.
C_{32}	192	75·00	74·96
H_{32}	32	12·50	12·87
O_4	32	12·50	....

0·1857 grms. lauric acid gave 0·4917 grms. carbonic acid and 0·202 grms. water.

		Theory.	Experiment.
C_{24}	144	72·00	72·21
H_{24}	24	12·00	12·06
O_4	32	16·00	....

A portion of the crude wax was repeatedly treated with fresh quantities of boiling alcohol until no further solution ensued, the residue was several times crystallized from hot ether, and finally after decolorization with animal charcoal, maintained in a state of fusion for some time to remove volatile impurities derived from the ether. It possessed the fusing point, hardness, and other properties of pure *palmitin*. Since according to Bostock, boiling alcohol dissolves only four-fifths of the wax, the amount of palmitin present may be approximately stated at one-fifth of the whole.

The results of the foregoing experiments indicate that the wax of the Myrica cerifera consists of about *one-fifth* part of *palmitin*, the remaining *four-fifths* being free *palmitic acid* with a small quantity of *lauric acid*, the latter either free or in the state of *laurin*.

With regard to the uses of this substance, its composition and abundance suggest it to the chemist as the most convenient and accessible source of pure palmitin and palmitic acid, and it will

probably be the means of increasing in no small degree our knowledge of these bodies and their derivatives. As a substitute for bees-wax in the manufacture of candles, the Myrica wax appears to be worthy of more attention than it has yet received. In illuminating power it seems to be scarcely, if at all, inferior to the best bees-wax. It can be furnished at less than one-fourth of the cost of the latter material, and owing to its superior hardness it can be cast instead of having to be subjected to the tedious and expensive process of moulding by hand. By care in preparation, it can be obtained more free from color than crude bees-wax, and moreover, it is said to be rendered perfectly white by the ordinary modes of wax bleaching. It might probably be used also with advantage to harden paraffine candles.

Taking into consideration the abundance of the plant itself, its hardy habits of life—in fact it thrives best upon soils which from their poverty and proximity to the sea are unfitted for all other purposes of cultivation—the slight degree of attention required to insure abundant crops, and finally the ease of extraction of the wax itself, there appears to be no reason why the preparation of myrtle wax should not constitute an important branch of manufacturing industry.*

The foregoing investigation was undertaken at the suggestion of Prof. Johnson, for whose guidance and assistance I here take pleasure in expressing my grateful acknowledgments.

Sheffield Laboratory, New Haven, Feb. 3d, 1862.

ART. XXX.—*Considerations relating to the Quebec Group, and the Upper Copper-bearing Rocks of Lake Superior;* by Sir W. E. LOGAN, F.R.S., Director of the Geological Survey of Canada.†

(Read before the Montreal Natural History Society, May, 1861.)

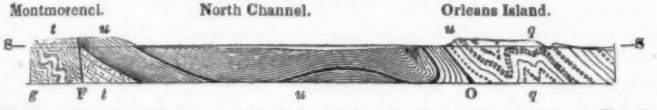
IN a communication addressed by me to Mr. Barrande on the fauna of the Quebec group of rocks, (this Jour., xxxi, 216,) after showing that the organic remains discovered last year at Point Lévis, placed the group about the horizon of the Calciferous formation, I stated that the apparent conformable superposition of the group on the Hudson River formation was probably due to an overturn anticlinal fold or overlap.

* In course of the preceding investigation a property of the *palmitate of silver* was noticed which I believe has not yet been placed on record. I allude to its becoming powerfully electric by friction. A small quantity of this salt, purified from extraneous fatty matters by digestion in ether, was gently rubbed in an agate mortar, when a sufficient amount of electricity was generated to cause the powder to fly out in every direction and cluster around the pestle and the hand holding it.—G. E. M.

† From the Canadian Naturalist and Geologist.

The character of this overlap is exhibited in the accompanying wood cut (fig. 1) of a vertical section of the neighborhood

1.—*Section from Montmorenci to Orleans Island.*



Horizontal and vertical scale, 1 inch to a mile. *g*, Laurentian gneiss; *t*, Trenton limestone; *u*, Utica and Hudson River formations; *q*, Quebec group; F, Fault; O, Overlap; S, Level of the Sea.

of Quebec, extending from the Montmorenci side of the St. Lawrence across the north channel and the upper end of the Island of Orleans. The road from Beauport to Montmorenci runs over a floor of Trenton limestone, which has a very small dip towards the St. Lawrence; farther back from the river the rock has a gentle dip in an opposite direction, giving evidence of a very flat anticlinal form, which could scarcely be detected without the aid of the general distribution of the formations in the neighborhood. On the south side of the road there occurs a dislocation, which can be traced the whole way from Beauport church to Montmorenci falls, where the effect it produces is easily discernible. Here the channel of the Montmorenci is cut down through the black beds of the Trenton formation, to the Laurentian gneiss on which they rest, and the water at and below the bridge flows down and across the gneiss, and leaps at one bound to the foot of the precipice, which, immediately behind the water, is composed of this rock. At the summit, the Trenton beds are seen on each side; on the right bank they have a thickness of about fifty feet, and are marked by the occurrence of *Leptæna sericea* (Sowerby), *Strophomena alternata* (Conrad), *Orthis testudinaria* (Dalman), *Lingula crassa* (Hall), *Conularia Trentonensis* (Hall), *Calymene Blumenbachii* (Brongniart), and *Trinucleus concentricus* (Eaton). The dip of these beds is down the stream, at a very small angle; but at the foot of the precipice, and immediately in contact with the gneiss, about the same thickness of black limestone is tilted up to an angle of fifty-seven degrees. This is followed by about an equal amount of black bituminous shale with the same slope. In this attitude, these rocks climb up the face of the precipice, presenting their edges to the chasm on each side. They are succeeded by about eight feet of hard grey sandstone, weathering brown, in beds of from ten to eighteen inches, interstratified with black shale. On this repose grey arenaceo-argillaceous shales, composing the sides of the chasm out to the waters of the St. Lawrence; the distance being about a quarter of a mile, and the dip, which is towards

the St. Lawrence, diminishing gradually to about thirty-five degrees.

These tilted beds are fossiliferous, the species contained in the limestone being *Stenopora Petropolitana* (Pander), *Ptilodictya acuta* (Hall), *Strophomena alternata*, *Leptæna sericea*, *Orthis testudinaria*, *Camerella nucleus* (Hall), *Lingula* allied to *L. obtusa*, *Discina crassa* (Hall), *Bellerophon bilobatus* (Sowerby), *Conularia Trentonensis*, an undetermined *Orthoceras*, *Cyrtoceras constrictum* (Hall), *Calymene Blumenbachii*, *Cheirurus pleurexanthemus* (Green), *Trinucleus concentricus*, *Asaphus platycephalus* (Stokes). Those contained in the black shales are *Graptolithus bicornis* (Hall), and *G. pristis* (Hessinger). There is thus no doubt whatever that the limestones are of the Trenton and the shales of the Utica formation.

On the opposite side of the north channel, at the upper end of the Island of Orleans, there occur about 500 feet of black bituminous shales, interstratified with occasional beds of gray yellowish-weathering calcareous sandstone, and arenaceous limestone. They in some parts hold *Graptolithus bicornis* and *G. pristis*, and there is little doubt are subordinate to the Utica or Hudson River formation. They dip S.E. $< 50°$, and there rests upon them (the contact being visible) a series of magnesian shales and conglomerates, dipping in the same direction and at the same angle. These magnesian strata are of the same character as those at Point Lévis, and belong to the Quebec group. They thus overlap the black shales, which are probably overturned as represented in the diagram (fig. 1).

In his explorations of last year on Lakes Superior and Huron, Mr. Murray ascertained that the lowest well characterized fossiliferous rock in that neighborhood belongs to the Birdseye and Black River group, and that it rests conformably upon the sandstones of Sault Ste. Marie. These sandstones and their equivalents, consisting of red and yellowish-white beds, are traceable on the south side of Lake Superior, from Marquette to the River St. Marie, and compose Sugar Island, and probably the north part of Neebish Island. They extend to the north part of St. Joseph Island, and are met with on the Island of Camp-

2.

a, Birdseye and Black River limestone; *b*, Ste. Marie sandstone; *c*, Huronian conglomerates; H, Level of Lake Huron; S, Level of the Sea. Horizontal and vertical scale, 1 inch to 1 mile.

ment d'Ours. In one of the white beds near Marquette, Mr. Murray obtained a *Pleurotomaria* resembling *P. Laurentina* of the Calciferous formation, and observed the occurrence, in the

same bed, of a species of *Scolithus*. The mass on Campment d'Ours is of the same color and friable character as the yellowish-white beds near Marquette, and is marked by the same *Scolithus*, and there is little doubt that the two exposures are of the same series. On Campment d'Ours the sandstone reposes on the Huronian series, and is eighty feet thick and very nearly horizontal, (fig. 2). It is succeeded in ascending order, by the following series of beds:—

Bluish-gray shales, interstratified with thin beds of yellowish compact limestone, presenting an escarpment over the sandstone. The fossils observed are *Stenopora fibrosa*, *Ptilodictya fenestrata*, *P. acuta*, *Strophomena alternata*, *Rhynchonella plicifera*, and a small undetermined *Lingula*,	20
Measures concealed,	60
Ash-gray compact limestone, in beds of from three to five inches thick, interstratified with a five-inch bed of drab colored compact limestone. Among the fossils are *Stenopora fibrosa*, *Glyptocrinus ramulosus*, *Strophomena alternata*, *Pleurotomaria subconica*, *Subulites elongatus*, *Ambonychia amygdalina*, *Cyrtodonta Huronensis*, *Vanuxemia inconstans*, *Orthoceras tenuifilum*, *O. Murrayi*, *Leperditia Canadensis*, and *Asaphus platycephalus*,	4
Ash-gray compact limestones, in beds of from four to six inches, underlaid by a dark brownish-gray arenaceous limestone bed of about ten inches, and divided by thin layers of gray calcareo-argillaceous shale. All of these strata are very fossiliferous, and contain *Glyptocrinus ramulosus*, *Ptilodictya multipora*, *Coscinium flabellatum*, *Strophomena alternata*, *S. filitexta*, *Rhynchonella recurvirostra*, *Orthis subequata*, *Vanuxemia inconstans*, *Cyrtodonta Huronensis*, *C. subcarinata*, *Pleurotomaria subconica*, *Trochonema umbilicata*, *Murchisonia perangulata*, *Orthoceras recticameratum*, *Cheirurus pleurexanthemus*, and *Leperditia Canadensis*,	30
Ash-gray compact limestone, of the same character as the preceding, but still more fossiliferous. The beds contain *Tetradium fibratum*, *Stenopora fibrosa*, *Columnaria alveolata*, *Petraia profunda*, *Strophomena alternata*, *S. filitexta*, *Rhynchonella recurvirostra*, *Ambonychia amygdalina*, *Cyrtodonta Canadensis*, *C. Huronensis*, *C. mytiloidea*, *Vanuxemia inconstans*, *Ctenodonta nasuta*, *Pleurotomaria subconica*, *Eunema strigillata*, *Subulites elongatus*, *Orthoceras tenuifilum*, *O. Murrayi*, an undescribed *Cyrtoceras*, *Asaphus platycephalus*, and *Leperditia Canadensis*,	16
	130

The fossils of these limestones leave little doubt that they belong to the Birdseye and Black River group; and the underlying sandstones and other rocks, constituting the upper copper-bearing series of Lake Superior, may thus represent the Chazy, Calciferous, and Potsdam formations, and be equivalent to the Quebec group, with the black shales and limestones beneath it. This equivalency and the existence of an upthrow bringing the Quebec

group to the surface in the regions to the southeast, as already described in my letter to Mr. Barrande (this Journal, xxxi, 216) suggest the following considerations.

From the occurrence of wind-mark and ripple-mark on closely succeeding layers of the Potsdam sandstone, where it rests immediately upon the Laurentian series, we know that this arenaceous portion of the formation must have been deposited immediately contiguous to the coast of the ancient Silurian sea, where part of it was in some places exposed at the ebb of the tide. No want of conformity is known to exist between the Potsdam and Calciferous formations, and the Quebec group being of Calciferous age and 7000 feet thick, it follows that during the Potsdam period, while the sandstones of the formation were being deposited on a level with the surface of the sea, there must have existed a depth of at least 7000 feet of water over the area in which were subsequently deposited the strata of the Quebec group.

With the exception of a small mass of the Potsdam sandstone at St. Ambroise, we have no evidence of a marginal outcrop of this formation between the St. Maurice River and the Mingan Islands. No marginal outcrops of the Calciferous and Chazy formations have been observed from the longitude of Lake St. Peter to the same group of islands; and between the vicinity of Kingston and the north shore of Lake Huron, all three of these formations appear to be wanting. From the Mingan Islands to the Mohawk River in New York, the marginal outcrops of the Potsdam, Calciferous and Chazy united do not in any part much exceed 1000 feet in thickness; while the thickness of the Quebec group alone, is about 7000 feet. This, constituting the great metalliferous formation of the continent, is traceable, under various designations, from Gaspé to Alabama, thence sweeping round on the west side of the Mississippi, through Kansas, to Lake Superior, where it appears without any diminution in its volume.

From these facts, it would appear probable that, during the Potsdam period, the older rocks, which formed the coast of the Lower Silurian sea, extended, under comparatively shallow water, southeastwardly from the St. Lawrence and the Ottawa, to the fault which brings the Quebec group between Gaspé and the Mohawk; and southwestwardly from a line between the Mohawk and Lake Superior, as far as Alabama. All around this shallow area, they descended quickly into deep water; thus constituting a subaqueous promontory from the Laurentian and Huronian rocks of the north, and forming, with these, what Mr. James D. Dana has termed the nucleus of the North American continent.

But although the great volume of the Quebec and Potsdam groups, shows that over the area occupied by them, there must have existed a deep sea during the Potsdam period; it is to be

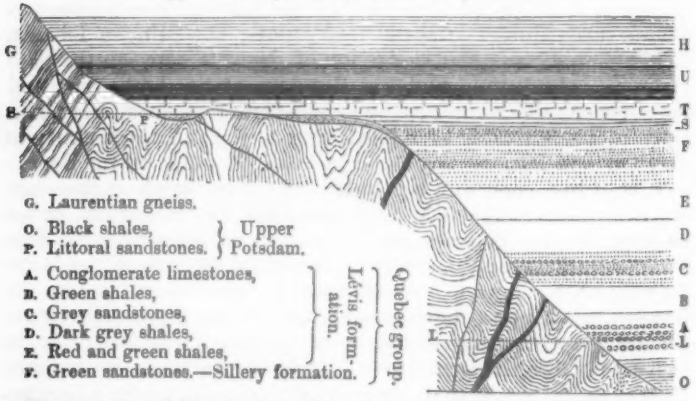
remarked, that many of the members, both of the lower and upper parts of the Quebec group, have by no means the characters of deep-sea deposits. It has already been stated, that the beds of passage between the littoral portions of the Potsdam and Calciferous formations, suggest the opinion, that, towards the termination of the Potsdam era, a gradual sinking of the surface had occurred. In order to obtain the conditions for the accumulation of the coarser sediments, which commence near the base of the Quebec group, it must be supposed, that, shortly after the beginning of the Calciferous period, a great continental elevation occurred; carrying the littoral deposits of the Potsdam, and the beds of passage just mentioned, high above the sea, and bringing the area at the base of the Quebec group comparatively near the surface. The successive coarse deposits of the group indicate a subsequent gradual subsidence, at unequal intervals, probably with subordinate oscillations, until the early shallow-water strata were again submerged; to be first partially covered over by deposits of the Chazy formation, and then, almost universally, by those of the Trenton and Hudson groups.

In this way may be explained the break which occurs in the succession of life between the Calciferous and Chazy, in the shallow-water deposits of these formations between the Allumettes Islands and Montreal, as well as among the Mingan Islands. The interruption in the succession of deposits between the base of the Trenton group and the Potsdam, at St. Ambroise; and that between the same base and the Laurentian, from the north shore of Lake Huron to Kingston, as well as in the vicinity of St. Paul and Murray Bays, and at Lake St. John on the Saguenay, is in the same way accounted for. The break in the succession of life between the Chazy and the Trenton group, is not so great as that between the Calciferous and the Chazy. It is not yet quite certain, that, at the marginal outcrop of the latter formations in Canada, a single species passes upwards into the Chazy; while about one-sixth of the species of the Chazy are known to occur in the Birdseye and Black River formation, at the base of the Trenton group. It seems to be in accordance with this, that we have evidence of a somewhat sudden submergence for the commencement of the Trenton period, and a somewhat rapid accumulation of its lower strata, the Birdseye and Black River limestones. Where these rest upon the Huronian and Laurentian series, the beds of contact are often composed of angular fragments of the underlying rock; and it frequently happens that the surface on which these beds rest, is rough, and broken into sharp projecting ledges and deep fissures, which were filled up and covered over by the deposits in question, before sufficient time had elapsed to permit the surface to be worn down. Instances in illustration of this occur on the Snake Islands, west of Lacloche, in Lake Huron, where the Birdseye

and Black River formation rests on the quartzites of the Huronian series; and at Marmora, where it is supported by Laurentian rocks. Dr. Dawson has pointed out a striking instance of these phenomena at Hog Lake in Huntingdon; other examples occur at Sloat's Lake in Loughborough and its vicinity, as well as at Kingston Mills. The same conditions may be observed in the neighborhood of Murray Bay.

As an instance of the probably rapid slope of the bottom of the Lower Silurian sea from shallow to deep water, during the Potsdam period, in the neighborhood of Quebec, we see that the surface of the quartzose gneiss now supporting the Trenton formation at the Falls of Montmorenci, must have been 7000 feet above the gneiss under the island of Orleans; while the distance between the two positions does not much exceed a mile and a half. This would give a slope of nearly forty-five degrees; and perhaps it would not be extravagant to take this as representing the inclination along the whole line to Alabama. As the Potsdam and Quebec groups accumulated, the edges of their strata would abut against this slope; and ultimately both these, and the early shallow-water deposits on the higher terrace, would be

3. *Supposed arrangement of the strata before the break.*



T. Trenton group of limestones; U. Utica shales; H. Hudson River sandstones and shales; L. L. Sea level at the commencement of the Quebec period; S. S. Sea level at the close of the Potsdam, and also at the beginning of the Trenton period. Vertical scale of the section, one inch to a mile.

covered over by the Birdseye and Black River, the Trenton, the Utica, and Hudson River formations. This we have endeavored to represent in the accompanying ideal diagram; in which it will be perceived that the lowest of these formations is shown as resting (at P.) on one of those littoral deposits of Potsdam sandstone, like that at St. Ambroise, which are still met with along the marginal outcrop.

The strike of this rapid slope in the bottom of the ancient sea, coinciding with the break, had, as already indicated, a general northeastward bearing, from Lake Champlain to the vicinity of Cape Chatte. The present trend of the Laurentian gneiss, from the neighborhood of Quebec to Pointe des Monts, has a rude parallelism with it; but farther down the valley of the St. Lawrence, while the line of break turns gradually eastward, and ultimately south of east, in Gaspé, the trend of the gneiss becomes northward for about sixty miles, then eastward for three hundred miles, and finally northeastward for two hundred miles more, to the Atlantic extremity of the Straits of Belle Isle. This divergence of the two lines would lead us to anticipate an area of shallow water during the Lower Silurian period; so protected from disturbance that any strata occurring there, might be expected to present a comparatively horizontal attitude, like that of the Lower Silurian formations on the same side of the break to the west. We accordingly find, in the Mingan Islands, in Anticosti, and on the Straits of Belle Isle, the Lower Silurian deposits in such an attitude. In the latter locality, however, the volume of the undisturbed strata would appear to indicate that the bottom shelved more gradually before reaching the slope. The increase of the dip in approaching Bonne Bay in Newfoundland, suggests that we may expect to find the break somewhere in that neighborhood.

Without enquiring into the origin of the forces which may have produced the corrugations of the earth's crust, we may suppose that if a sufficient lateral pressure were applied to the strata thus accumulated and arranged, there would result a series of parallel folds running in a direction at right angles to that of the force, with prevailing overturn dips towards the line of resistance. The solid crystalline gneiss in the case before us, offering more resistance than the newer strata, there resulted a break coinciding with the inclined plane at the junction of these with the gneiss. The lower palæozoic strata, pushed up this slope, would then raise and fracture the formations above, and be ultimately made to overlap the portion of these resting on the edge of the higher terrace; after probably thrusting over to an inverted dip, the broken edge of the upper formations. The shallow-water strata of the higher terrace, relieved from pressure by the break, would remain comparatively undisturbed; and thus the limit of the more corrugated area would coincide with the slope between the deep and shallow waters of the Potsdam period. The resistance offered by the buttress of gneiss would not only limit the main disturbance; but it would probably also guide or modify, in some degree, the whole series of parallel corrugations, and thus act as one of the causes giving a direction to the great Appalachian chain of mountains.

ART. XXXI.—*On the action of substances of the Sulphur and Phosphorus Groups on solutions of the metals;* by THEODORE PARKMAN. (Abridged from his Inaugural Dissertation, Göttingen.)

THE subject of the following dissertation was suggested by an observation made in the laboratory of Prof. Wöhler, at Göttingen. In precipitating selenium, by sulphurous acid, from a solution which contained considerable copper, the selenium obtained was black, although the precipitation took place in the cold. On investigation, the selenium was found to contain copper. My honored instructor, Prof. Wöhler, suggested to me that, as this reaction was a new and somewhat singular one, to extend it to tellurium, sulphur, phosphorus, arsenic and antimony, might afford the matter for a not uninteresting investigation.

I. *Action of Sulphur on the solutions of Copper, Silver and Lead.*

As just mentioned, precipitated selenium, placed in a solution of sulphate of copper containing sulphurous acid, unites with copper. I find that sulphur, tellurium, phosphorus, arsenic and antimony all do the same. In most cases also, the same effect is produced, especially with the aid of heat, without the presence of sulphurous acid or other reducing agent. I have also extended the investigation, though less completely, to the salts of silver and lead. With the exception of the action of phosphorus on the copper and silver solutions, all these reactions appear to have been previously undescribed.

1. *Action of sulphur without the aid of reducing agents.*—Precipitated sulphur and flowers of sulphur were left a week in solutions of sulphate, acetate and chlorid of copper. At the end of that time, they were entirely unchanged. Precipitated sulphur, boiled five or six hours with the sulphate, was slightly blackened, from formation of sulphid. Precipitated sulphur and flowers of sulphur, boiled with the acetate, rapidly blackened and were finally, apparently, entirely converted into sulphid of copper. Sulphur,* left three days in solution of nitrate of silver, became dark grey. Boiled in solution of nitrate of silver, it became rapidly black and seemed to be entirely converted into sulphid of silver. Sulphur, boiled with acetate of lead, only by very long boiling became dark grey.

2. *Action of sulphur with the aid of reducing agents.*—Sulphur, left for some hours in solutions of sulphate, acetate and chlorid of copper, with which sulphurous acid was mixed, became gradually dark grey, from formation of sulphid. Left a week in similar solutions, it appeared to be almost entirely converted into dark blue or black sulphid of copper. By boiling the solutions, the reaction took place much more rapidly, the sulphur becoming black in a few minutes. Sulphur, green vitriol and

* In all the following experiments the sulphur used was precipitated by sulphuric acid from hyposulphite of soda.

sulphate of copper, boiled together, gave sulphid of copper rapidly. Sulphur, zinc and sulphate of copper, boiled together, gave, along with reduced copper, black sulphid.

Sulphur, boiled with acetate of lead and acetate of the protoxyd of iron, became rapidly black and was apparently completely converted into sulphid. The resulting sulphid contained no iron.

3. *Analysis of the products of the foregoing reactions.*—In preparing the above substances for analysis, my great care was to continue the action long enough to be sure that all the sulphur was converted into sulphid. In those prepared by simply boiling the sulphur with the solution of the metal, the boiling was continued from five to eight hours, in every case with an excess of the metallic salt. In preparing the sulphids by the aid of sulphurous acid, the sulphur was placed in the solution of the metal, the whole heated, though not to boiling, and then saturated with sulphurous acid gas. The solution was then boiled, allowed to cool, again saturated with sulphurous acid, and left to stand a couple of days in a closed flask. In every case, on opening the flask, there was still an excess of the metallic salt and of sulphurous acid. To prevent oxydation, the substances, during washing, were kept covered with water, as much as possible, and dried in vacuo. In none of them could any free sulphur be seen by the aid of the lens. Of each substance two preparations were made, in order to see if the composition of the substance remained constant.

For analysis, the substances were all dissolved by digestion with fuming nitric acid, which, in nearly every case, dissolved them completely, without separation of sulphur. The analyses of the copper compounds were made, in some cases, by precipitating the oxyd of copper, at the boiling point, by caustic potash, and the sulphuric acid from the filtrate, after acidulation, by chlorid of barium. In other cases, separate portions of substance were taken for the copper and sulphur determinations. The silver compounds were all analyzed by precipitating, first the silver by chlorhydric acid, and then the sulphuric acid, from the filtrate, by chlorid of barium.

Sulphid of copper prepared by boiling sulphur with acetate of copper.

1st preparation. 0·6946 grm. substance gave 0·2817 oxyd of copper and 2·6436 sulphate of baryta.

2d preparation. 0·3255 grm. substance gave 0·1479 oxyd of copper and 1·2938 sulphate of baryta.

	I.	II.
Cu,	32·37	36·28
S,	52·27	54·56
	84·64	90·84

Sulphid of copper obtained by the aid of sulphurous acid.

1st preparation. I. 1·9560 grms. substance gave 1·3145 oxyd of copper.
II. 1·7321 grms. substance gave 1·1615 oxyd of copper.
III. 0·6727 grm. substance gave 2·0356 sulphate of baryta.

2d preparation. I. 1·8346 grms. substance gave 1·4830 oxyd of copper.*
II. 2·2385 grms. substance gave 5·4626 sulphate of baryta.

		I.	III.	II.
1st prep.	Cu,	53·76		53·54
	S,	41·54		
		95·30		

			Calculated.	I. II. Found.
2d prep.	Cu,	31·7	66·46	64·54
	S,	16·	33·54	33·51
		47·7	100·00	98·05

Sulphid of silver prepared by boiling sulphur with nitrate of silver.

1st preparation. I. 2·0266 grms. substance gave 1·6800 chlorid of silver and 4·9156 sulphate of baryta.
II. 1·3725 grms. substance gave 1·1359 chlorid of silver and 3·2839 sulphate of baryta.

2d preparation. 0·4670 grm. substance gave 0·3519 chlorid of silver and 1·4593 sulphate of baryta.

		I.	II.
1st prep.	Ag,	62·39	62·28
	S,	33·31	32·86
		95·70	95·14

			Calculated.	Found.
2d prep.	Ag,	108	57·45	56·70
	5S,	80	42·55	42·91
		188	100·00	99·61

The formula CuS, derived from one of the above analyses is probable enough. The formula AgS^5 is not a probable one, and the substance is perhaps a mixture of the ordinary sulphid of silver with unchanged sulphur. No sulphur, however, could be seen by the aid of a lens. The substance was apparently a perfectly homogeneous, dark-grey powder. Lumps of it, when crushed, had the same appearance.

* According to Rose (Analytische Chemie, ii, 187) in igniting oxyd of copper, the filter may be burned along with the precipitate, and any suboxyd formed may be reoxydized by means of the current of air, which may be directed into the crucible by means of the cover. This is probably true in most cases, but sometimes there may be considerable loss through reduction. In the above analysis, after weighing once, I ignited and weighed again. The substance had increased considerably; and only after ignition, in a current of air, of three or four hours in all, and a total increase in weight, from the first weighing to the last, of 0·0568 grm. (=3·1 per cent of the substance analyzed) was a constant weight obtained. On breaking up the lumps of oxyd of copper, some red suboxyd still remained, which had been protected from oxydation by the coat of protoxyd on the outside. This would account, in part at any rate, for the percentage of copper in the above analysis coming out too low. It is decidedly advisable to burn the filter separately. This was done in my other analyses, with one exception, in which, from its close correspondence with another analysis, little or no loss appeared to have been incurred.

It will be seen that, in the analyses of the above substances, two preparations excepted, there is a large loss, if the substances be supposed to consist only of sulphur and metal. That this loss is not owing merely to incorrect analyses is shown by the pretty close correspondence of the analyses of the first preparation of sulphid of silver and of two of the copper determinations. I at first supposed that the sulphids had partly oxydized to sulphates: but, on heating them, first with water and then with dilute sulphuric acid, either none at all or only a trace was dissolved. Any sulphate, or other salt of silver or copper with the sulphur acids, should have dissolved up in the dilute acid. Heated in a dry test-tube, none of the substances gave any water. These facts led me to suppose that perhaps the presence of an oxysulphid, either alone, or mixed with a sulphid, might not be impossible. On examining the analyses in which there was a loss, I find that the analysis of one of the sulphids of copper corresponds closely to the formula $CuOS^3$,*

		Calculated.	Found.
Cu,	31·7	36·15	36·28
O,	8·	9·12	
3S,	48·	54·73	54·56
	88·7	100·00	

This formula is an improbable one, and I regret that I had not the time to investigate the subject further.

The analyses of the other sulphids did not correspond to any formula. When carefully examined under a lens, the copper compounds appeared to contain two substances. At first they appeared to be simply composed of a deep blue or blue-black powder. On breaking some of the lumps, however, these latter were found in many cases to be composed of a hard, light colored substance, with a reddish tinge and somewhat metallic appearance. Its appearance was very much like that of protosulphid of iron, which has been fused and then broken. The substance, which corresponded to the formula $CuOS^3$, was almost perfectly homogeneous and was different in color from the other copper compounds. It was dark grey, nearly black, without the bluish tinge of the others. The sulphids of silver were dark grey, one nearly black, the other considerably lighter. Both appeared to be perfectly homogeneous.

With regard to the manner in which the sulphids are forming by boiling sulphur with the salts of silver and copper, it might be supposed that one portion of the sulphur would be oxydized at the expense of the oxyd of the metal, while another portion of sulphur would unite with the metal thus set free. Whether this is the case or not, appears to be somewhat doubtful. After boiling sulphur a long time with solutions of acetate of copper and nitrate of silver, until the sulphur was well blackened, the filtrates were tested for sulphuric acid. In the copper solution none

* The oxysulphids already described are ZnO, ZnS, CoO, CoS, and MnO, MnS, described by Arfvedson (Pogg., 1), AsO^3S^2 by Bouquet and Cloez (N. Ann. de Chim. et Phys., 13, 14; J. der Pharm., 7, 23), and red antimony-ore, SbO^3, $2SbS^3$. Of all these, the only one, the composition of which bears much resemblance to the formula ($CuOS^3$), is the arsenic compound; and from the wide dissimilarity between arsenic and copper, this analogy is of but little value as a proof of the probability of the above formula.

was found; in the silver only a trace. Another portion of each filtrate was then tested for other acids of sulphur, by boiling with nitric acid and then adding chlorid of barium. No sulphur separated, on adding the acid, and chlorid of barium gave merely a trace of sulphate of baryta in the silver solution; none in the copper solution. It is possible that the sulphur may be oxydized to sulphurous acid. No smell of this could be detected, during boiling; but as the action of the sulphur is not very rapid, the sulphurous acid may have been given off in too small quantity to have been detected. Against this hypothesis, however, are the following considerations. As has been shown, sulphurous acid and other reducing agents greatly assist the formation of the sulphids, and this can be owing only to their reducing power. Now, if the sulphur be oxydized to sulphurous acid, some of this latter would be oxydized to sulphuric acid, of which, in the copper solution at least, not a trace could be detected. If the sulphur is not oxydized and no reducing agent be present, it would seem that one of two suppositions must be adopted: either the sulphur sets the oxygen of the oxyd free, which, I take it, is highly improbable, or the oxygen still remains in combination with the metal and an oxysulphid is formed. The substances no doubt vary with the circumstances under which they are formed—length of time in boiling, concentration of solution, &c.,—since two of the analyses made agree with the formulas of sulphids, without oxygen. One of these was formed with the aid of sulphuric acid. In the other, it may be supposed that the sulphur perhaps in this case acted as a reducing agent.

II. *Action of Sulphurous Acid on the Solutions of Copper.*

As sulphurous acid was used in forming several of the compounds above described, I deemed it advisable to make some investigation into the action of sulphurous acid alone on the solutions of copper used.

Sulphurous acid in most cases produces no effect on the compounds of copper with the stronger acids. Under certain circumstances, however, a solution of sulphate of copper gives with sulphurous acid a small quantity of the well known red sulphite of protoxyd and suboxyd of copper ($CuO, SO^2 + Cu^2O, SO^2 + HO$, Rammelsberg), and in other cases small crystals of metallic copper.*

The action of sulphurous acid upon acetate of copper does not appear to have yet been observed. I found that sulphurous acid gas passed through a solution of acetate of copper, heated, though not to boiling, gave at first a yellowish precipitate. This dissolved up again as the operation was continued, and the solution deposited a large quantity of small, bright red crystals. The reactions of these corresponded to those of the red sulphite, mentioned above. This gives, therefore, a new method of preparing the above salt.

The yellowish precipitate, just mentioned, may also be obtained by adding sulphurous acid water, in small quantity, to a solution of acetate of copper, which contains little or no free acid. After washing and drying it was of a yellow color, with a slight greenish tinge. It appeared to be entirely insoluble in water. No crystals could be detected by the lens.

* Wöhler, Ann. der Chem. u. Pharm., lxxix, 126–127.

With sulphuric acid it gave off sulphurous acid in large quantity. By solution of caustic potash it was converted into a bright green, insoluble substance.* By boiling with caustic potash, it gave black oxyd of copper. A portion, dried in vacuo, over sulphuric acid, gave off considerable water, on heating in a closed tube. It was found to contain no alkali, and no acetic acid.

For analysis, the salt was boiled with chlorine water until it dissolved, the sulphuric acid precipitated by chlorid of barium, the excess of chlorid of barium by sulphuric acid, and the oxyd of copper, at the boiling point, by caustic potash.

1·2266 grms. substance gave 1·0341 sulphate of baryta and 0·6975 oxyd of copper.

		Calculated.	Found.
2CuO,	79·4	57·37	56·86
SO^2,	32·	23·12	23·15
3HO,	27·	19·51	
	138·4	100·00	

The salt is very soluble in sulphurous acid, to a green solution. The latter, by standing, deposits the red sulphite. Acetic acid has a precisely similar effect. In preparing the salt, therefore, the solution of acetate of copper must be neutral and the sulphurous acid added in small quantity. If too much acid be added, the precipitate will be redissolved, even before the solution smells of sulphurous acid.

The salt appears to be hitherto undescribed. The only mention I can find of anything similar is in a paper on the sulphites, by Böttinger.

Böttinger,† by mixing a solution of sulphate of copper with sulphite of ammonia containing but a small quantity of free sulphurous acid, obtained a dirty greenish-yellow precipitate, which, on the addition of a little sulphurous acid, was rapidly and easily converted into a beautiful green liquid. This yellow precipitate he did not investigate further. I prepared a quantity of it for comparison with the salt which I obtained. The color of the two substances varied considerably from each other. That obtained by means of sulphite of ammonia was brownish-yellow, with little or no greenish tinge. That prepared from acetate of copper was of a much brighter yellow, with a decided tinge of green. Böttinger's salt, however, gave precisely the same reactions as mine. With strong acids it gave off sulphurous acid in large quantity. With caustic potash it became bright green. By boiling with caustic potash it became black and gave no smell of ammonia. The two salts, therefore, are no doubt identical.

III. *Action of Red Selenium on the solutions of Copper, Silver and Lead.*

1. *Without the presence of reducing agents.*—Red selenium, left four days in solutions of sulphate and acetate of copper, still remained red, showing that it had not combined with copper. The same, boiled with

* The green color was owing, probably, to the presence of a little hydrated suboxyd of copper, the yellow color of which, with the blue of the hydrated oxyd, would give green.

† Ann. der Chem. u. Pharm., li, 410.

sulphate of copper, for a long time, did not take up any copper. Boiled with acetate of copper, however, it was found to have united with considerable copper.

For analysis of the product of this last reaction, red selenium was boiled several hours with acetate of copper, thoroughly washed, and dried in vacuo. The substance obtained was a black powder, mixed with hard lumps, which, when broken, had a somewhat metallic lustre. For analysis, it was dissolved in nitric acid, the oxyd of copper precipitated, at the boiling point, by caustic potash, washed, dried, and ignited with saltpetre and carbonate of potash.

0·5237 grm. substance gave 0·0507 oxyd of copper.

		Equivalents.
Cu, - - -	7·73	1
Se (by difference),	92·27	9·7
	100·00	

Hence it would seem that the selenium was only partly converted into selenid of copper, notwithstanding that the boiling was kept up five hours, or more.

Red selenium, left four days in solution of nitrate of silver, gave a black powder, along with a few white flakes of (probably) selenious acid. After dissolving out the latter by means of caustic soda, the black powder was found to contain selenium and silver, both in large quantity. No free selenium could be seen in it, by the aid of the lens. (See remarks on the action of tellurium on nitrate of silver.)

Red selenium, boiled a long time with acetate of lead, took up no lead.

2. *With the aid of reducing agents.*—As already mentioned, red selenium, with sulphate of copper and sulphurous acid, becomes black, through formation of selenid of copper.

For analysis, a portion was prepared in the same manner as the corresponding sulphid of copper. The product obtained was a black powder, nearly homogeneous, but containing a few glistening particles, which looked like metallic copper. The substance was dissolved in nitric acid and the oxyd of copper precipitated as usual by caustic potash. The separation of copper and selenium in this manner is not quite perfect, a little selenious acid being usually precipitated, along with the oxyd of copper. Accordingly, the copper in the following analysis comes out somewhat too high.

2·0735 grms. substance gave 0·8336 oxyd of copper.

		Calculated.	Found.
2Cu,	63·4	61·61	62·00
Se,	39·5	38·39	
	102·9	100·00	

This same compound may also be formed by heating copper with selenium, or by igniting the protoselenid in a close vessel. (Berzelius.) It is also found native.

Red selenium, boiled half an hour with acetate of lead and acetate of the protoxyd of iron, did not take up any lead.

IV. *Action of Precipitated Tellurium on the solutions of Copper, Silver and Lead.*

1. *Without the aid of reducing agents.*—Precipitated tellurium, left four days in solutions of sulphate and acetate of copper, did not unite with any copper. Boiled with sulphate of copper, four or five hours, it also remained unchanged. Boiled with acetate of copper, it took up considerable copper. Some of the product of this action, obtained by boiling the tellurium four or five hours with the acetate, consisted of a black powder, containing a few glistening particles, otherwise homogeneous. An analysis of it was made as follows. The substance was dissolved in aqua regia and the oxyd of copper precipitated by caustic potash, dried, and ignited with nitre and carbonate of potash. To free the oxyd entirely from tellurous acid, it was again boiled with caustic potash. After weighing, the oxyd of copper was tested for tellurium and was still found to contain a trace.

0·2671 grm. substance gave 0·0831 oxyd of copper.

		Calculated.	Found.
2Cu,	63·4	24·82	24·82
3Te,	192·	75·18	
	255·4	100·00	

This and the following are, I believe, the only analyses that have been made of a tellurid of copper. Gmelin (Handbook of Chem. Engl. Transl.) merely mentions that tellurid of copper is pale red, according to Berzelius.

The action of tellurium upon nitrate of silver has been observed by Fischer: viz., that it acts very freely upon the solution of nitrate of silver, and forms a black powder, which does not assume the metallic lustre under pressure. Fischer does not mention whether the black powder was tellurid of silver or metallic silver, but leaves it to be inferred that it was the latter, as the observation is given in connection with the reducing action of the metals upon the salts of silver. That tellurid of silver is formed is probable from the analogous action of sulphur upon nitrate of silver, as well as of selenium and tellurium on acetate of copper. The following experiment also makes this probable. Precipitated tellurium was left four days in solution of nitrate of silver. At the end of that time, the solution still contained a large excess of silver. The black powder appeared under the lens to be perfectly homogeneous and to contain no white flakes of tellurous acid. It was found to contain silver and tellurium, both in large quantity. Now, if metallic silver was precipitated by the tellurium, probably little or no tellurium would remain unoxydized, after being in contact so long with an excess of the silver solution, but would either pass entirely into solution (the hydrate of tellurous acid dissolves in water with tolerable facility—Berzelius), or, if there was not enough liquid present to dissolve the whole, be visible as white tellurous acid.

Precipitated tellurium, boiled a long time with acetate of lead, precipitated no lead.

2. *With the aid of reducing agents.*—Precipitated tellurium, heated with sulphate of copper and sulphurous acid, united with considerable copper. For analysis of the product of this reaction, a portion was pre-

pared in the same manner as the corresponding sulphid of copper. The substance obtained was a black powder. It was ignited with nitre and carbonate of soda, and the oxyd of copper separated from the melted mass by dissolving in water. This method is not to be recommended. The platinum crucible used was attacked somewhat (perhaps because there was not enough nitre), and platinum was thus mixed with the oxyd of copper. To separate them, the oxyd of copper was ignited a long time, to bring all the platinum into the metallic state, and then dissolved out with nitric acid and precipitated by caustic potash. A better mode of analysis is that given in the analysis last described.

0·9498 grm. substance gave 0·3818 oxyd of copper.

		Calculated.	Found.
Cu,	31·7	33·12	32·09
Te,	64·	66·88	
	95·7	100·00	

Precipitated tellurium, boiled half an hour with acetate of lead and acetate of the protoxyd of iron, did not combine with any lead.

V. *Action of Phosphorus on the solutions of Copper, Silver and Lead.*

1. *Without the presence of reducing agents.*—The action of phosphorus on solutions of copper has already been observed by Bœck, Vogel and Bœttcher, and I have but little new to add to their observations.

Phosphorus, placed in a boiling solution of sulphate of copper, gave at first metallic copper, but this gradually blackened and by continued boiling appeared to be entirely converted into phosphid. This has been also observed by Böttcher. For analysis, I prepared some of the above phosphid by boiling phosphorus five or six hours with sulphate of copper. The substance obtained was a black powder, the larger particles possessing considerable lustre. Under the lens it appeared to be perfectly homogeneous. Even when finely pulverized, not a trace of metallic copper could be seen. Heated on platinum foil, here and there a very slight flame was observed for two or three seconds. The quantity of free phosphorus, however, if there was any present, must have been extremely small.

For analysis, a portion was dissolved in hydrochloric acid, with the aid of chlorate of potash, the solution heated until it no longer smelled of chlorine, diluted, and the copper precipitated by sulphuretted hydrogen. The filtrate was saturated with ammonia, and the phosphoric acid precipitated by sulphate of magnesia (mixed with chlorid of ammonium in sufficient quantity to prevent its precipitation by ammonia). The sulphid of copper was dissolved in fuming nitric acid and the oxyd precipitated by caustic potash.

0·6695 grm. substance gave 0·7301 oxyd of copper and 0·2916 phosphate of ammonia-magnesia.

		Calculated.	Found.
7Cu,	221·9	87·74	87·06
P,	31·	12·26	12·16
	252·9	100·00	99·22

The phosphids of copper previously described are Cu^6P, Cu^3P, and Cu^2P.

Phosphorus in solution of nitrate of silver throws down metallic silver, as observed by Bœck. The silver has the usual color and metallic lustre, and is apparently crystalline. No phosphid could be seen.

Phosphorus, left three days with a solution of acetate of lead in a closed test-tube, gave merely a few white flakes, probably of phosphate of lead. On boiling, a black precipitate was rapidly formed in large quantity, along with white phosphate of lead. After dissolving out the latter with caustic potash, the black substance was dissolved up in nitric acid, and tested for phosphoric acid. None was found: so that the substance, it would seem, was metallic lead.

2. *In the presence of reducing agents.*—Solution of sulphate of copper was saturated with sulphurous acid, phosphorus added, the whole heated somewhat, and left three days in a closed flask. On opening the flask, the solution was colorless. The result was metallic copper, and black phosphid of copper, along with unchanged phosphorus. I did not attempt to analyze the phosphid, as it was so intimately mixed with finely divided metallic copper that it was impossible to obtain it pure.

VI. *Action of Arsenic on the solutions of Copper, Silver and Lead.*

1. *Without the aid of reducing agents.*—Pulverized metallic arsenic, boiled with sulphate of copper, took up considerable copper. For analysis of the product of this reaction, pure metallic arsenic, pretty finely pulverized, was boiled several hours with concentrated solution of sulphate of copper. The substance obtained was a perfectly homogeneous, dark-grey powder. It was dissolved up in hydrochloric acid, with the aid of chlorate of potash, and digested at a very gentle heat with excess of chlorate of potash, in order to make sure of converting all the arsenic into arsenic acid, until the solution was nearly free from chlorine. The solution was then made strongly alkaline with ammonia and the arsenic acid precipitated by a mixture of sulphate of magnesia and chlorid of ammonium. This was washed with water, containing considerable ammonia, brought upon a weighed filter and dried at 100° C. From the filtrate, after acidulation, the copper was precipitated by sulphuretted hydrogen, dissolved in fuming nitric acid and reprecipitated by caustic potash.

1·0225 grms. gave 0·7211 arseniate of ammonia magnesia ($2MgO, NH^4O, AsO^5, +HO$) and 0·9276 oxyd of copper.

		Calculated.	Found.
6Cu,	190·2	71·72	72·43
As,	75·	28·28	27·83
	265·2	100·00	100·26

The arsenids of copper previously described are Cu^4As and Cu^2As.

Arsenic in solution of nitrate of silver throws down metallic silver, as already observed by Fischer.

2. *With the aid of reducing agents.*—Pulverized metallic arsenic, heated with solution of sulphate of copper and sulphurous acid, forms

arsenid of copper. For analysis, a portion was prepared in the same manner as the corresponding sulphid of copper. The substance obtained was a dark-grey, perfectly homogeneous powder. Two arsenic determinations were made, in the same way as in the last analysis.

I. 1·1215 grms. substance gave 1·4189
2MgO, NH^4O, AsO^5+12HO (dried in vacuo).

II. 0·3235 grm. substance gave 0·2650
2MgO, NH^4O, AsO^5+Ho (dried at 100° C.).

		Calculated.	Found.	
			I.	II.
5Cu,	158·5	67·88		
As,	75·	32·12	32·78	32·33
	233·5	100·00		

Pulverized arsenic, boiled half an hour with acetate of lead, precipitated no lead. With acetate of the protoxyd of iron and acetate of lead, it also produced no effect.

VII. *Action of Antimony on the solutions of Copper, Silver and Lead.*

1. *Without reducing agents.*—Pulverized antimony, left three days in solutions of sulphate and acetate of copper, took up considerable copper, in both cases. A little white oxyd of antimony was also formed. By boiling, the action takes place more rapidly, and a large quantity of the oxyd is formed.

As already observed by Fischer, antimony precipitates metallic silver from the nitrate. Towards the end of the action, some antimonid of silver is also formed, according to Fischer.

Antimony, boiled a long time with acetate of lead, produced no effect.

2. *With reducing agents.*—Pulverized antimony, left three days in solution of sulphate of copper, mixed with sulphurous acid, combined with considerable copper. No white oxyd could be seen. In acetate of copper the same effect was produced.

Antimony, boiled with acetate of the protoxyd of iron and acetate of lead, did not throw down any lead.

ART. XXXII.—*An Account of two Meteoric Fireballs, observed in the United States, Aug.* 2, *and Aug.* 6, 1860, *with computation of their paths;* by H. A. NEWTON, of Yale College.

I. *Meteor of Aug.* 2, 1860.

THIS magnificent fireball appeared about five minutes after ten, P. M., Cincinnati mean time, and was seen over the whole region from Pittsburg to New Orleans, and from Charleston to St. Louis, an area of nine hundred miles in extent. Through the kindness of friends, and from newspaper notices, I have been able to collect much information respecting it, the most important of which is presented in the following summary. I wish to express my indebtedness to Mr. Robert Brown, Jr., of Cincinnati, for valuable assistance. Materials which he had collected for his own use he has generously placed at my disposal.

1. *The path of the meteor through the atmosphere.*

Mr. Samuel Schooler, M.A., Principal of the Edge Hill School, Guiney's, Va., (N. lat. 37° 58′, W. lon. 77° 52′), saw it move North, its path being inclined downward at an angle of 10° with the horizon. At my request, he measured with a theodolite the place of first appearance, viz: S. 59½° W., alt. 7° 12′. It passed behind obstructions S. 70° W.

Prof. Evans, of Marietta College, Ohio, says: "B. K. Shaw, Esq., of Marietta, (lat. 39° 29′, lon. 81° 26′), saw the meteor pass near certain definite landmarks, such as tops of trees, chimneys, &c. It first appeared to him about 11° West of South, at an altitude of 8° or 9°. It was just emerging from behind a clump of trees. He saw it pass through the topmost branches of a tree 28° West of South, at an altitude of 6° or 7°. It disappeared behind a church, S. 43° W., at about the elevation of the eaves, that is, about 4° above the horizon. I took these angles with a theodolite as Mr. Shaw pointed them out with a ruler."

Rev. J. McD. Mathews, D.D., of the Hillsboro Female College, (N. lat. 39° 15′, W. lon. 83° 30′), says that a young lady saw first a bright light, then a ball of fire, which passed the window 60 feet from her, in range with the upper part of it. Its course was descending. The middle of the window was 20° or 25° W. of S. from her, and the middle of the upper panes 7½ feet higher than her eye, giving an altitude of 7° 8′.

Mr. Robert Brown, Jr., of Cincinnati, (N. lat. 39° 6′, W. lon. 84° 27′) gives S. 5° W., alt. 12°, for one point of its path.

Peraz R. Polley, Esq., of Ironton, Ohio, (N. lat. 38° 35′, W. lon. 82° 30′), says its altitude when first seen was 15°, and that it disappeared due S.W., at an altitude of 7°.

Prof. T. A. Wylie, D.D., of Bloomington, Ind., (N. lat. 39° 12′, W. lon. 86° 26′), says that by referring to the top of a house which was nearly in a line with the meteor, he is able to determine that the altitude of no part of the track could have exceeded 8°. The brightest light first caught his eye near S. 22° E.

Madison, Ind., (N. lat. 38° 45′, W. lon. 85° 18′). Seen S. 15° E. at half the elevation of the moon (25°). Disappeared S. 5° E.

At St. Louis, (N. lat. 38° 37′, W. lon. 90° 15′), its altitude when first seen in the S. E. was said to be 3°, and about half that at disappearance in the East.

Mr. F. C. Herrick, of Bowling Green, Ky., (N. lat. 37° 0′, W. lon. 86° 24′), sent me a diagram which makes its path horizontal, and passing under the moon at less than half the altitude of that body.

At Pitts Cross Roads, Tenn., (N. lat. 35° 40′, W. lon. 85° 10′), it was said to come from the moon's place in the heavens. Mrs. J. W. Redfield saw it, when it was a little East of North, apparently proceeding Northerly.

Nashville, Tenn., (N. lat. 36° 10′, W. lon. 86° 49′). Apparently it passed under the moon which was then S. 53° E., 26° high.

Rome, Tenn., (N. lat. 36° 14′, W. lon. 86° 6′); it came from the S.E., and moved N.E.

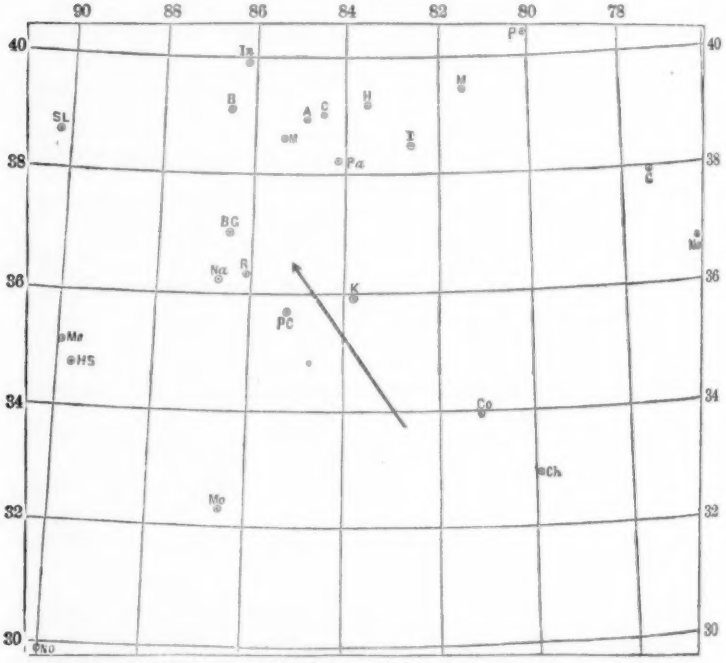
Montgomery, Ala., (N. lat. 32° 23′, W. lon. 86° 28′), started in the N.E. and went down almost due North.

Holly Springs, Miss., (N. lat. 34° 48′, W. lon. 89° 44′). Appeared in the Southeast, and exploded near the Northeast horizon. Greatest altitude 30°.

Charleston, S. C., (N. lat. 32° 46′, W. lon. 79° 56′), appeared nearly in the West at an altitude of about 40°. It did not disappear till very near the earth.

Many other indications of the path are given in the newspaper notices before me, but the estimates of altitudes are too great, or else the directions are manifestly in error.

1.



These observations indicate that the body first became visible over Northeastern Georgia about 82 miles above the earth's surface, near N. lat. 33° 50′, W. lon. 82° 40′, and that it exploded nearly over N. lat. 36° 40′, W. lon. 85° 5′, that is, over the south-

ern boundary line of Kentucky, at an altitude of 28 miles. The length of the visible path was about 240 miles, and its direction N. 35° W. The position of the places of observation, and of the meteor's path, are indicated in the chart, (fig. 1) in which the places are marked by their initial letters.

The following table affords the means of comparing the above observations with the computed path. In the third and fourth columns are given the azimuths and altitudes at which points of the line given above would be seen at the several stations. The altitudes are corrected for refraction. When the azimuths are those of the beginning or end of the assigned path, it is indicated in the 2d column. The altitudes in the last column are derived from the observations.

Place.		Azimuth.	Comp. alt.	Obs. alt.
Marietta, ...	Beg.	S. 11° W.	9° 00′	8° or 9°
"		S. 28 W.	6 40	6 or 7
"	End.	S. 43 W.	4 30	4
Guiney's, ...	Beg.	S. 47 W.	8 15	
"		S. 59½ W.	5 45	7 12′
"		S. 70 W.	3 30	5 25
Ironton, ...	Beg.	S. 2 W.	12	15
"	End.	S. 48 W.	6 45	7
Cincinnati, ...		S. 5 W.	8 25	12
Bloomington, ...	Beg.	S. 31 E.	8	not over 8°
"	End.	S. 22 E.	7 15	"
Madison, ...	Beg.	S. 23 E.	10 10	12 30
"	End.	S. 5 E.	10 15	12 30
Hillsboro, ...		S. 22 W.	7 10	7 8
St. Louis, ...	Beg.	S. 54 E.	5 15	3
"	End.	S. 66 E.	3 10	1 30
Charleston, ...	Beg.	N. 66 W.	24	40
"	End.	N. 47 W.	1 30	above horiz'n.
Nashville, ...	Beg.	S. 57 E.	14 30	
"	End.	N. 70 E.	15	
Pitts C. Roads, ...	Beg.	S. 48 E.	22 15	
"		S. 52 E.	24 3	27
"	End.	N. 4 E.	21 15	
Bowling Green, ...	Beg.	S. 45 E.	13 15	
"		S. 52 E.	15	12 30
"	End.	S. 72 E.	19 15	

2. The duration of flight, and the velocity.

Mr. Schooler, who is accustomed to the use of the transit instrument, gives six seconds. The estimate was made at the time. Mr. Shaw gives from five to seven seconds.

By others the following intervals were assigned. At Ironton, 2ˢ; Rome, 3ˢ; Charleston, 5ˢ or 6ˢ; Morrow, Ohio, 6ˢ or 7ˢ; Aurora, 10ˢ; Antioch Coll., 10ˢ; Pittsburg, 15ˢ; St. Louis, 15ˢ; Holly Springs, 15ˢ; Madison, 30ˢ; Cincinnati, Louisville and Nashville, several seconds; Chilicothe, nearly a minute.

These estimates lead me to consider 7 or 8 seconds as the most probable time of flight for the whole line. The corresponding

velocity is 30 or 35 miles a second. The heliocentric velocity is on this supposition 24 or 28 miles. The latter velocity would indicate a hyperbolic orbit. The least possible heliocentric velocity for a body describing the given line is about 15 miles a second.

3. *Sounds heard after the explosion.*

Dr. Jas. W. Redfield, at Pitts Cross Roads, writes, that about five minutes after its passage they heard a tremendous explosion, and immediately another not quite so loud, in the direction in which the meteor had proceeded. They were re-echoed in the opposite direction with the prolonged roar of thunder. To the ear the explosion was like the booming of distant cannon.

Dr. Alex. McCall, of Rome, says that five or ten minutes after its passage there came a hundred sounds, like cannon fired in a deep hole, or like a great bass drum pelted by some giant keeping time.

Mr. W. C. Kain, of Knoxville, says that three minutes after the meteor had vanished, a long, reverberating sound was heard, of at least a minute's duration.

Paris, Ky. It was said to have been followed by a dull heavy sound like thunder.

As Paris is 125 miles from the place of explosion, the source of the sound may however be questioned. The above are the only reliable accounts which I have seen from those who heard the explosion.

4. *Magnitude of the body.*

It is most natural to measure the apparent size of a meteor by the moon's disc. From such a comparison and the distance of the observer the diameter of the body is at once computed. But this gives, I am convinced, a result very wide of the truth. The estimate of size is always vague. Irradiation too seems to prevent the diminution of apparent diameter naturally due to increased distance. This appears by comparing the estimates of the size of the meteor of Aug. 2d, made at different distances from its path, as below. The numbers indicate the distances to the nearest point of the meteor's path.

Knoxville,	(50);	head much larger than Mars.
Pitts C. Roads,	(50);	large as the moon, second ball not as large.
Bowling Green,	(80);	at first large as Venus, grew to the size of the moon.
Columbia,	(120);	two feet in diameter.
Aurora,	(170);	nearly as large as the moon.
Cincinnati,	(175);	large as a barrel.
Bloomington,	(190);	greater than the moon.
Ironton,	(200);	large as a barrel.
Hillsboro,	(200);	large as the moon or larger.
Portsmouth,	(200);	larger than the moon.
Antioch Coll.,	(230);	equal to the moon.
Indianapolis,	(230);	at first large as a man's hand, grew to the size of the moon.
Enon, Ohio,	(235);	first like a shooting star, grew to the size of a cocoanut.

Holly Springs, (270); at first not much larger than Mars, grew to exceed the rising moon. Others said large as the moon, large as a barrel, and two feet in diameter.
Marietta, (280); nearly twice as large as the moon.
Memphis, (290); large as the moon.
St. Louis, (310); from one-half to the full size of the moon.
Pittsburg, (385); large as the moon.
Guineys, (400); at first large as a star of the 1st mag., but grew in size and brilliancy until the whole western part of the heavens was brilliantly illuminated.
Norfolk, (415); each part as large as a butter keg.

This table indicates that an increase of distance does not produce any decrease in the assigned size. In fact there is rather an opposite tendency. It is useless then to compute the diameter of a meteor's nucleus (or of the flame even, if it is flame that we see,) by comparing its visible diameter with that of a heavenly body, as the moon. Thus we may get in the present instance four miles, or half a mile, according as we use the more distant, or the nearer observations. For anything I can see the smaller of these diameters may be a hundred, or even a thousand times greater than that of the nucleus.

In several of the accounts mention is made of a regular, or an irregular increase in the apparent size of the meteor, and that too when the meteor was not approaching the observer. Such an increase, if true, must be due to increased brilliancy, and hence to irradiation, or else to a larger body of flame. In either case the larger diameter evidently does not belong to the meteoric body.

5. Colors of the body and of the train.

Some persons classify meteors according to color. Those seen by a single careful observer may perhaps admit of such an arrangement. But this classification seems of little use when the meteors are seen by different and unpracticed observers. The nuclei of the meteor of Aug. 2d were said to be, white—pearl—rose color—pale red—red—bright red—crimson—saffron—yellowish—greenish—bluish—blue. The corona and train were bluish—bluish white—blue—green—yellow—rose color—reddish—pale red—red—bright red—crimson—scarlet—dazzling white.

6. Brilliancy.

In brilliancy this must be ranked in the first class of meteors. Its train was not many degrees in length. The path of the meteor of July 20th, 1860, was longer, and its motion more deliberate and stately. Yet this exhibition was, I am convinced, in most respects more magnificent than that of its noted predecessor.

It did not leave the atmosphere—for its path was downward, inclined more than 10° to the horizon of the place of explo-

sion. It terminated abruptly, and that at a point low down in the atmosphere. It is impossible that it should have escaped again without a continuance of its visible path, and change of direction.

It must have been a solid body.—This is inferred; 1st, from the tremendous detonation that followed it; 2d, from its breaking up into several parts before disappearance; 3d, from visible explosions during the flight, during which multitudes of sparks were sent off; 4th, from its penetrating the atmosphere so far; 5th, from the similarity of the phenomena to those when aerolites are seen to come down.

Whether any parts of the body came to the ground except as fine dust it is impossible to say. Its tremendous velocity seems quite sufficient to entirely dissipate any substance.

I think it probable that only those meteors whose relative velocities are quite slow furnish aerolites. Those whose relative velocities are large are burnt up, or dissipated, before reaching the ground.

II. *Meteor of Aug. 6, 1860.*

On the evening of Aug. 6th, 1860, at about $7^h\ 38^m$ New York mean time, a very bright fireball was visible even in the strong twilight, from Pittsburg, Pa., to Roxbury, Mass. Its brilliancy was compared by several observers to that of Venus, and to that of Mars, which was then very bright in the southeast. To the nearer observers it was very much more brilliant than those planets. Near the middle of its course it appeared to distant observers to separate into two parts, while those who were nearer saw it continually giving off fragments. Had it appeared later in the evening it would perhaps have rivalled in brilliancy the displays of July 20th, and Aug. 2d. At Pittsburg and Buffalo the sun had gone down but 5^m before. No undoubted accounts of an audible explosion have been received.

Mr. Arthur N. Hollister saw the meteor from the roof of a house in New Haven (N. lat. 41° 18′, W. lon. 72° 55′). Two days afterwards I went with him to the place, and from his description of its path determined its places of appearance and disappearance to be, S. 80° W., alt. 6° to 7°, and N. 70° W., alt. 5°. To obtain the period of flight I requested him to suppose the meteor to pass again over the same arc of the heavens, with the same velocity as before, while the interval was noted by the watch. I cautioned him against making the motion too rapid. Three or four trials gave a result of 8 seconds. Another person who was with him gave 5 seconds for the interval, but 7 or 8 seconds was considered the more probable time of flight.

Mr. Homer G. Newton, the brother of the writer, saw the meteor from Sherburne, N. Y. (N. lat. 42° 41′, W. lon. 75° 33′).

and observed carefully its path with a view to future measurements. On the evening of Aug. 11th I went with him to the place of observation, and he described the track of the meteor which I recorded by referring it to stars then visible. A few days later I measured with a quadrant and compass the altitudes and azimuths as pointed out by him. The first measurements gave for the points of appearance and disappearance S. 59° W., alt. 11¼°, and N. 84½° W., alt. 9¼°; the second gave S. 54½° W., alt. 12° to 12½°, and N. 84° W., alt. 9° to 9½°.

The period of flight, determined as in the New Haven observation, was in several distinct trials given always as 6 seconds.

Washington McClintock, Esq., saw the meteor from Pittsburg, Pa. (N. lat. 40° 32′, W. lon. 80° 2′). It passed across an open space between trees two or three hundred feet distant. His son, then a member of the Senior Class in Yale College, was called, but not in time to see it. The apparent path was immediately located as accurately as possible with reference to the trees. Measurements made some months later gave S. 82½ E., alt. 10¾°, and N. 39° E., alt. 11⅓° for the places of its emergence and disappearance behind the trees.

Mr. William Wheeler saw the meteor from Crum Elbow Point (N. lat. 41° 45′, W. lon. 73° 56′), on the east bank of the Hudson river, five miles above Poughkeepsie. When first seen it was 6° to 10° above the horizon, S. 80° W., and it sailed slowly northwesterly, inclined gradually downward, and disappeared behind the high hills about N. 70° W. Time of flight, 8 to 10 seconds.

All these persons except Mr. McClintock are recent graduates of Yale College. I have felt that the four observations were worthy of more than ordinary confidence. United with a large number of newspaper and other accounts, they indicate that the following straight line is not far from the true path of the meteor both in direction and position: starting from a point 39 miles above the earth, nearly over the southern line of Pennsylvania (N. lat. 39° 35′, W. lon. 76° 45′), and passing N. 80° W. to a point 36 miles high, west or northwest of Buffalo. Its length is 225 to 250 miles, and its least height above the earth 35 miles.*

In the 3d column of the following table I give the altitudes at which this line would be seen at these four and at other places at the azimuths assigned. In the 4th column are corresponding observed altitudes, obtained from newspapers and other sources.

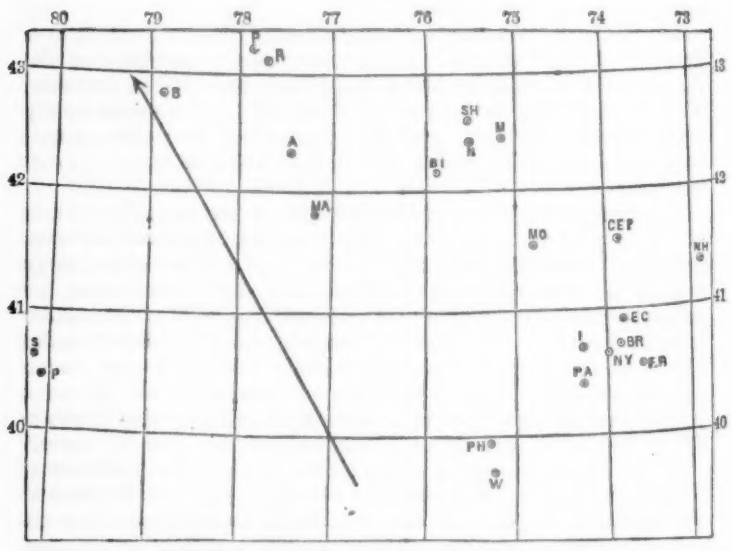
* Since this article was in type, Mr. R. T. Comstock of Westfield, N. Y. (N. lat. 42° 17′, W. lon. 79° 37′) writes to me that it passed 30° N. of the zenith of that place. As it disappeared at Buffalo towards the setting sun, the place of extinction is probably nearer N. lat. 43°, W. lon. 80°, than is represented in the chart. I have not however thought best to change the text. This change of path renders a hyperbolic orbit more probable.

When the azimuth has not been mentioned, I have assumed that that of the greatest altitude was meant.

Place.	Azimuth.	Comp. alt.	Obs. alt.	Place.	Azimuth.	Comp. alt.	Obs. alt.
	°	° ′	°		°	° ′	°
New Haven, ..	S. 80 W.	7 5	6	Philadelphia,	S. 85 W.	22 10	12½
"	N. 70 W.	3 35	5	"	N. 52 W.	8 30	6½
Sherburne, ...	S. 57 W.	11 10	12	"	West.	21	25
"	N. 84 W.	9 40	9½	"	N. 70 W.	15 30	20
Pittsburg, ...	S. 82 E.	14 25	10½	"	N. 40 W.	5	9
"	N. 39 E.	14 15	11½	Woodbury, .	West.	22 45	40
Crum Elbow Pt.,	S. 80 W.	8 30	6 to 10	Norwich, ..		12 15	10 or 15
"	N. 70 W.	5 15		Binghamton,	S.W.	17 15	20
Far Rockaway,	West.	8 30	15	"	N. 70 W.	10 30	12
Brooklyn, ...	S. 75 W	11 15	10	Avoca, ...		31	40
New York, ...		12 15	20	Mansfield, ..		35	40
East Chester, ..	West.	8 30	20	Rochester, ..		25 45	45
Irvington, ...		13 20	14½	Parma, ...		26 30	30
Perth Amboy, .	West.	11 30	30	Sewickley,..		15	35

The positions of these places are indicated in the following chart (fig. 2) by their initial letters.

2.



The duration of flight and the velocity.

Mr. Wheeler gives eight or ten seconds for the passage of the meteor over 180 miles of its course. This gives a velocity of about 20^{m} a second.

The Sherburne observation gives six seconds for 115 miles, or 19^{m} a second.

Mr. Hollister gives 7 or 8 seconds for 215 miles, or 29^{m} a second.

Mr. Pratt of Binghamton saw the meteor for a course of about 190 miles. He rose from his seat and walked across the street during its flight to avoid losing sight of it behind buildings. Eight or ten weeks later he walked over the same space with what he considered the same speed, while I noted the interval, 15 seconds. Had this been done immediately after seeing the meteor it would have afforded by far the best determination of the time of flight. But a person under excitement must move more quickly than he would weeks afterward suppose. An interval of 15 seconds gives a velocity of nearly 13 miles.

Mr. Crowel who saw it from Sherburne gave 8 seconds as the interval of flight. Mr. Arthur G. Newton who saw it from Parma, N. Y., gave 6 seconds. The same method of obtaining the time was employed in both cases as in the New Haven observation. In the newspaper notices the following periods were assigned: at Roxbury, Mass., 10 or 15^{s}; Sharon, Ct., 15^{s} to 20^{s}; New York City, 5^{s}; Perth Amboy, 30^{s} to 45^{s}; Brooklyn 10^{s} to 15^{s}; Ironton, N. J., 10^{s} to 15^{s}; Morris, N. Y., 12^{s}; Riverdale, 30^{s}; Mansfield, 70^{s}; Avoca, 15^{s}; Evensburg, 8^{s} to 10^{s}; Danville, 40^{s}; Monticello, 30^{s} to 45^{s}; Rochester, 12^{s}.

I give all of the times assigned. But it is evident that the longer periods ought to be rejected. Disregarding those of 30 or more than 30 seconds, the average of the remainder is 11 seconds. Assuming that the observers saw the meteor describe on the average three fourths of its visible trajectory we have a velocity of 16 miles a second. But if we reject also the Sharon and Avoca observations, we have a velocity of 19 miles.

Unless there is a constant error in the method made use of at New Haven and Sherburne for ascertaining the interval of flight, eighteen miles a second must be considered a tolerable approximation to the true geocentric velocity. It is worthy of remark that the observers were in very favorable positions for estimating the time, the motion across the sky being quite uniform.

To obtain the heliocentric velocity it may be well to allow for the effect of the earth's attraction even though the amount of the correction is decidedly less than the probable errors of the observation, and are perhaps less than the effects of the resistance of the atmosphere. The increment of velocity due to the earth's attraction is 1^{m}·4 and the change of direction nearly 5°. These corrections applied to the direction and velocity above given would make the velocity 16^{m}·6 a second, towards R. A. 108° 30′, Dec. +43° 45′. The parts of the earth directly under the meteor were moving towards R. A. 42° 7′, Dec. +16° 15′. The heliocentric velocity of the meteor is then 30^{m}·4, towards R. A. 67° 45′, Dec. +33° 25′.

This of itself indicates a hyperbolic orbit.—Let us therefore inquire whether any changes are admissible that will make the

orbit an ellipse. The path of the meteor cannot be carried much to the eastward so as to shorten its length, and thus diminish the velocity. Its azimuth may be changed, several degrees even, without great violence to the observations, but this will have little effect upon the heliocentric velocity.

The meteor cannot reasonably be supposed to have ascended during the larger part of its course. On the other hand, to change it so as to make it describe a descending line would increase the heliocentric velocity.

Any change then must be in the duration of the flight. If the body was moving about the sun in an elliptic orbit, and the line given above was its true path, the geocentric velocity could not be greater than about 14 miles a second, which would require 16 or 18 seconds for the whole flight. This would moreover make no allowance for the resistance of the atmosphere. Though an elliptic orbit is very possible I can hardly think it probable.

Yale College, March, 1862.

ART. XXXIII.—*On Orthite from Swampscot, Mass.;* by DAVID M. BALCH, B.S.

MORE than a year since, while examining the rocks at Swampscot Beach, near the Clifton House, I observed a mineral occurring in small amorphous masses in quartz and red feldspar, which immediately attracted my attention by its peculiar lustre and appearance; this on examination has proved to be orthite almost identical with that from the Norway granite.

The shore at Swampscot and for half a mile or so N.E. towards Marblehead, consists of ledges of rock, against which the sea breaks, ranging from sienite to porphyry, and extending 50 or 60 feet backward, and, at the most, from 15 to 20 feet in height, to the pasture land above; these rocks are very rugged, seamed with trap, veins of quartz and red feldspar; in the latter occur good specimens of fibrous epidote, and the mineral furnishing the subject for this paper.

The orthite is found almost always imbedded in quartz, but I have obtained a few pieces from the feldspar, which forms the bulk of the veins; it occurs in black amorphous masses, sometimes surrounded with a reddish coating of sesquioxyds of iron and cerium, when much exposed to the weather or the action of the sea; and in very small quantity, for I only obtained a few grammes in return for searching the rocks throughout their whole extent. I examined this mineral shortly after its discovery, sufficiently to determine its name and general composition, and more carefully again this winter, and give below an outline of the method of analysis, and its results.

The orthite of this locality appears always to occur massive, at least no specimens that I have found show any signs of crystal faces.

Sp. gr. at 18° C. 3·69—3·71. Lustre, resinous and in some cases nearly vitreous. Color, jet black, and streak gray. Heated in thin splinters before the blowpipe, fuses slowly to a black blistered glass; dissolves readily in borax and gives a globule, red when hot, but yellow after cooling; with soda gives a slight manganese reaction; in its natural state is very easily decomposed by chlorhydric acid, but after ignition is not affected by it in the least.

A small portion being reduced to powder, dried at 110° C., and then ignited, lost 1·49 per cent of combined water.

The preliminary analysis was performed on ·445 grms.; from it I ascertained the composition of the mineral, but was unable to determine accurately the amount of those substances present in small quantity. My method of analysis was that given by Wöhler,* in which cerium, yttria, &c., are separated from iron and alumina by moist carbonate of baryta. The following results were obtained:

Silica,	32·62
Alumina, Ferric-oxyd,	29·47
Ceric-oxyd, &c.	24·74
Lime,	8·05

Magnesia and soda were also present.

The ceric oxyd, &c., weighing about a decigramme, was examined for yttria, and abundant traces of it found; also inconsiderable traces of manganese.

The succeeding analyses undertaken principally to ascertain the amount of yttria present, were conducted as follows: A quantity of the levigated mineral, dried at 110° C., was decomposed in a porcelain dish by chlorhydric acid, (sufficient nitric acid being added during the operation to peroxydize the iron) and the silicic acid separated as usual: the filtrate from the silica was then supersaturated with ammonia by which oxyds of iron, aluminum, cerium and yttrium were thrown down, the magnesia being held in solution by the chlorid of ammonium formed by the excess of chlorhydric acid present in the liquid; this precipitate, which I will designate by *a*, was completely washed by decantation and then on a filter, and the washings, evaporated to a small bulk, were mixed with the filtrate; from this the lime was thrown down by oxalate of ammonia, and weighed first as carbonate and then as sulphate; in the filtrate from the lime magnesia was precipitated by phosphate of soda, as I did not intend to determine the amount of soda or potassa which may have been present; manganese was also present in such small tracess that it was disregarded.

In order to separate the ceric-oxyd and yttria from sesquioxyd

* Practische Uebungen in der chemischen Analyse, Göttingen, 1853, s. 112.

of iron and alumina in precipitate *a*, I digested it, while still moist in aqueous oxalic acid; the separation was perfect, and the insoluble oxalates obtained were free from iron; after standing 24 hours, these were well washed, dried, ignited and weighed as ceric-oxyd and yttria. The sesquioxyd of iron and the alumina, contained as acid oxalates in the filtrate and washings of the above, were now separated, in the first case as usual, by potassa; in the second analysis by evaporating to dryness, igniting to destroy oxalic acid and expel ammoniacal salts, peroxydizing any reduced iron by nitric acid, and weighing the mixture of $Al_2O_3+Fe_2O_3$ as a control to the first analysis.

These analyses were performed exactly alike, with the exception given above, the first on ·782 grms., and the second on 1·032 grms. of substance.

To separate yttrium and cerium oxyds, I employed the following process given in Rose's Handbuch der analytischen Chemie, Braunschweig, 1851, Bd. 2, s. 72. The ceric-oxyd, &c., from both analyses, weighing nearly five decigrammes, was fused with bisulphate of potassa, the mass digested with a warm solution of sulphate of potassa sufficiently concentrated to deposit crystals on cooling, and the insoluble sulphate of potassa and cerium entirely washed out with this solution; yttria was thrown down from the decanted liquid and filtrate by excess of potassa, and weighed as such; it contained a little manganese.

The following results were obtained by these analyses:

	A		*B*
Silica,	33·31		32·94
Alumina,	14·73	Al_2O_3 }	33·60
Ferrous oxyd,	15·82	Fe_2O_3 }	
Cerous oxyd,	21·94		20·71
Yttria,	1·32		1·32
Lime,	7·85		7·87
Magnesia,	1·25		1·47
Soda,	(undetermined)		
Water,	1·49		1·49
	97·71		99·40

In orthite and allanite about half the iron is usually in the state of sesquioxyd; in analysis *A*, all the iron is calculated as protoxyd which occasions the apparent loss; an attempt was made to determine the amount of protoxyd present, by the chlorid of gold and sodium process,* but it was unsuccessful, and could not be repeated for want of material.

These analyses and the physical properties of the mineral, prove it to be orthite, very closely resembling that from Hitteroe, Norway.†

It is interesting to remark that this is the first instance of the occurrence of yttria in New England, if we except the single specimen of yttrocerite, found sometime since in Worcester Co.,

* Rose's Handbuch, Bd. 11, s. 129. † Dana's Mineralogy, 1854, p. 210.

Mass., the locality of which is unknown. As our rocky New England ledges are more extensively examined or quarried, we have reason to hope that they may yield some of the other rare minerals of the Scandinavian granites.

Salem, Feb. 6th, 1862.

ART. XXXIV.—*A new Metal in the Native Platinum of Rogue River, Oregon;* by C. F. CHANDLER, Professor of Chemistry at Union College.

IN examining native platinum from the above locality, more than a year ago, I became convinced of the probable existence of a hitherto unobserved metal. I have deferred publishing my observations, hoping to obtain material for a more complete examination; in this I have thus far been disappointed.

The quantity of platinum examined amounted to only a few grammes. It was digested with hydrochloric acid to remove impurities, and the solution thus obtained was subjected to the ordinary routine of qualitative analysis.

A brown precipitate was produced by hydrosulphuric acid, which dissolved readily in hydrochloric acid on the addition of a crystal of chlorate of potassa. In this solution metallic zinc produced a precipitate which resembled metallic tin, obtained under similar circumstances. This precipitate dissolved readily in hydrochloric acid on the application of heat, but the solution thus obtained had no effect on a solution of protochlorid of mercury (HgCl), and on cooling deposited a small quantity of minute crystals. To guard against error these experiments were repeated two or three times on small portions of the original solution, always with the same result.

The chlorid of this metal differs therefore from the protochlorid of tin, in not reducing protochlorid of mercury to calomel, and in being but slightly soluble in the cold.

On mentioning my observations to a friend, I was referred to Dr. F. A. Genth's announcement of a new metal, made in 1852,* of which I was not previously aware.

The metal observed by Dr. Genth occurred among grains of platinum from California. It was malleable; it fused readily on charcoal before the blowpipe, becoming covered with a coating of black oxyd; it dissolved in borax to a colorless bead, which became opalescent on cooling; it was dissolved by hot hydrochloric acid and by nitric acid; and its solution gave a brown precipitate with hydrosulphuric acid. It seems quite probable therefore, that the metal which I have observed in the Rogue River platinum, is identical with that observed by Dr. Genth.

Schenectady, March 6, 1862.

* Proceedings of the Philad. Acad. Nat. Sci., Dec. 1852, and this Journal, [2], xv, 246.

ART. XXXV.—*Notice of the Rocks lying between the Carboniferous Limestone of the Lower Peninsula of Michigan and the limestones of the Hamilton Group: with descriptions of some Cephalopods supposed to be new to science;* by ALEXANDER WINCHELL, State Geologist of Michigan.

THROUGHOUT the counties of Hillsdale and Calhoun, and the southern half of Jackson county, in the Lower Peninsula of Michigan, occur frequent outcrops of a fine, friable ferruginous sandstone whose stratigraphical position in this part of the state, is not more than forty or fifty feet below the Carboniferous limestone. The whole thickness of the series is less than 300 feet. The upper portion of this succession of sandstone strata is more grayish than the lower, more firmly cemented, and more homogeneous; and it has thus far proved remarkably destitute of organic remains. The lower portion of the series, which is separated from the upper by fifteen feet or more of shale, is of a dingy-reddish or yellowish color, with a very conspicuous amount of ferruginous matter, often disposed in bands conformable with the lamination of the rock, or producing a rude concretionary structure, and not unfrequently solid nodules and bands of ironstone. At Battle Creek in Calhoun county, these strata, when not weathered, are of a bluish color, and firmly cemented by an abundance of calcareous matter. At Hillsdale and Jonesville in Hillsdale county, these sandstones are thicker-bedded, more fine and homogeneous, and incline more to an olive color. The lowest strata here are bluish, shaly and highly micaceous. The most instructive exposures of this part of the sandstone series occur at Hillsdale, Moscow and Jonesville in Hillsdale county, and at Marshall, Ceresco and Battle Creek in Calhoun county. At most of these localities, especially those in Calhoun county, the sandstone is well stocked with fossil remains belonging to the genera *Goniatites*, *Nautilus*, *Orthoceras*, *Bellerophon*, *Nucula*, *Solen*, *Myalina*, *Chonetes*, &c. These lower fossiliferous sandstones have been designated the "Marshall Group," and the upper, unfossiliferous beds the "Napoleon Group," though it will appear obvious there are no very conclusive reasons for separating the two groups.

From this part of the state, the outcrops of these two groups are believed to trend northeast and northwest in curved belts toward Pt. aux Barques and the mouth of Grand river. Toward the northwest, the next actual exposure known is in the township of Holland, Ottawa county, and west of there to the vicinity of Lake Michigan; though the intervening space affords numerous loose fragments of the formation. The Napoleon sandstone is seen again near Grandville in Kent county, and

the Marshall sandstone near the center of Ottawa county. Toward the northeast, the next actual exposure occurs near the sources of the Cass river in Sanilac county, whence the sandstones are traceable to the shore of Lake Huron, which they occupy from the mouth of Pigeon river to Pt. aux Barques.

The fine-grained sandstones of the southern part of the state are overlaid by the saliferous and gypsiferous clays of the "Michigan Salt Group," attaining a thickness of 184 feet at Grand Rapids and Saginaw, but in Jackson county attenuated to less than 50 feet. They are underlaid in Branch, Calhoun, St. Joseph and Van Buren counties, by a considerable thickness of argillaceous strata sometimes plastic and abounding in Kidney iron ore, sometimes shaly, and sometimes blackened with bituminous matter. They contain very few fossils.

In the vicinity of Pt. aux Barques, the typical Marshall sandstone is separated by two feet of conglomerate from the bluish, fine-grained, homogeneous gritstone, from which have been manufactured the famous Huron grindstones. These are succeeded downwards by a great thickness of dark, fissile, somewhat bituminous shales, with intercalated flagstones, striking nearly southward in lines parallel with the lake shore in Huron and Sanilac counties, and occupying, as is believed, a large portion of the bed of the lake between Saginaw Bay and Port Huron. At a lower level occur the black bituminous shales of Kettle Pt. on the Canadian shore, and Sulphur island and Squaw Pt. at the head of Thunder Bay on the Michigan shore. At the latter localities, these are succeeded by the fossiliferous limestones of the Hamilton group. The black shales are seen again near the mouth of Grand Traverse Bay, covered by a few feet of green shale, and underlaid as before by the Hamilton limestones. No rocks of the age of the Hamilton Group have been recognized as yet, in the southern part of the state.

The following is a synoptical view of the strata embraced in the foregoing sketch; aggregate thickness over 800 feet.

Carboniferous limestone,		66 feet.
Michigan Salt Group,		184 "
Napoleon Group,		123 "
(*d*) Shaly micaceous sandstone,	15	"
(*c*) Napoleon sandstone,—highly saliferous in many localities,	78	"
(*b*) Shaly, micaceous sandstone,	15	"
(*a*) Clay and shale, more than	15	"
Marshall Group,		173 "
(*d*) Reddish, yellowish and greenish sandstones,	147	"
(*c*) Shaly, micaceous sandstone,	10	"
(*b*) Conglomerate,	2	"
(*a*) Fine, bluish gritstones,	14	"

Huron Group,		210 feet.
(*c*) Shales, limestones and flagstones,	180	"
(*b*) Green shale,	10	"
(*a*) Black bituminous shales,	20	"
Hamilton Group,		55 "

The reëxamination of the ferruginous sandstones and underlying shales, which have been made within the last two or three years, have tended to confirm the opinion long entertained that they are the equivalents of certain formations in other northwestern states whose true geological horizon has not yet been settled by the general consent of American geologists. The interest which attaches to any definite information bearing upon the controverted question of the exact age and equivalents of these rocks, would seem to justify the attempt to make known the facts in my possession. I accordingly submit the following notice of some characteristic fossils occurring in the rocks under consideration:

Descriptions of Cephalopods from the Marshall and Huron Groups of Michigan.

ORTHOCERAS INDIANENSE.

O. Indianensis Hall, 13th Rep. N. Y. Regents, p. 107.

Septate portion of shell more than 3·75 inches* in length; inclination of sides forming an apical angle which varies in different specimens from 6° to 11°; transverse section circular; septa at right angles with the central siphon; ratio of depth of chamber to its diameter, in different specimens 2·0, 2·67, 2·71 and 3·46; ratio of concavity of septum to its diameter 2·81; ratio of diameter of siphon to diameter of shell 5·67. No surface markings discernable on the cast.

Localities. The most abundant *Orthoceras* in the Marshall sandstone. I have specimens from Marshall, Calhoun county, Holland, Ottawa county, Moscow and various other points in Hillsdade county, and from Hard Wood Pt. (one mile S.W. of Pt. au Pain Sucre) on the shore of Saginaw Bay in Huron county.

The specimens from Michigan exhibit all the characters published, of *O. Indianensis* Hall, except the apertural constriction, with reference to which I have not been enabled to make any observations. The casts of this species cannot be distinguished from those of *O. cinctum* Sowerby, as defined by de Koninck ("Animaux Fossiles," p. 513, pl. xliii, fig. 6; xliv, 5; xlviii, 3). It is equally undistinguishable from *O. Goldfussanum* de Kon. (op. cit., 510; pl. xliii, 3, 4), except that the septa of this species are separated by only about one-eighth of their diameter.

* The measurements in the following descriptions are all given in inches. Where a measurement is followed by a number in parentheses, the latter is the *relative* dimension, the greatest measure given in the description being assumed as 100.

ORTHOCERAS ROBUSTUM, n. sp.

A septate fragment of this species has such a curvature that the individual must have been 3·4 in diameter. Amongst other fragments of the last chamber of the shell, one is so large as to imply a diameter of 4·6. The septa appear to be transverse, separated from each other ·31, where the diameter is 3·4, giving a ratio of 11. In another specimen this ratio is ·15 : ·98=6·54. No surface markings are indicated upon the casts. Siphon not seen.

Localities. Marshall, Moscow and Hanover in Jackson county.

This species has the size and general appearance of *O. giganteum* Sow. (de Kon., op. cit., 510, pl. xliv, 2; xlv, 3; xlvi, *a*, *b*; xlvii, 1), but differs, as far as observed, in having the septa separated by one-sixth to one-eleventh of their diameter, instead of one-third. It differs from *O. crassum* F. Röm. (Sandberger, "Versteinerungen," p. 164, Taf. xix, fig. 1) by a much greater approximation of septa; and this reason, as well as its very great size, has induced me to separate it from *O. Indianense*.

ORTHOCERAS VITTATUM.?
Sandberger (Verstein., 165; Taf. xx, 9).

Shell very gradually tapering; transverse section circular; ratio of the depth of the chambers to their diameter ·09 : ·22= 2·56; ratio of concavity of septa to their diameter ·07 : ·22=3·14. Siphon apparently slightly excentric. Surface (of cast) marked by delicate encircling bands, separated by rather sharp, fine grooves; four of these bands correspond to each chamber. There are also very feeble indications of striæ covering the bands.

Locality. In the Marshall sandstone at Battle Creek or Holland.

The single specimen in my possession differs from Sandberger's description only in the words "taeniis transversalibus *paullo obliquis*." It differs from *O. bicingulatum* Sandberger (Verstein., 162, Taf. xvii, 3) in the transverse direction of the rings, and the perfectly circular section.

ORTHOCERAS ARCUATELLUM.?
Sandb. (Verstein, 166; Taf. xix, 2).

Shell tapering to an angle of 12°; nearly smooth externally, with faint, encircling, unequal, irregularly sinuous striæ; section circular; septa transverse, with a convexity equal to one-sixth or one-seventh their diameter; siphon central. (?)

Locality. In the Marshall sandstone at Marshall.

The general characters of this shell present a good agreement with the species to which I have doubtfully referred it; but it is easy to point out differences. Our shell has a much less rapid taper, and the encircling striæ are much finer, more unequal, and not regularly reflexed on the anterior and posterior sides; moreover, no observations have yet been made on the depth of

the chambers, while the position of the siphon admits of some doubt.

ORTHOCERAS OCCIDENTALE, n. sp.

Septate portion of shell more than 3¾ inches in length; greatest apical angle 8° to 12°; transverse section an ellipse whose minor axis is to the major as ·37 : ·48=1·3; septa nearly transverse with a concavity equal to about one-fifth the greater diameter; interseptal space about one-fourth the same diameter. Siphon situated on the minor axis about midway between the center and periphery, constricted where it passes through the septa, about ·06 in diameter in the chamber and ·04 in the constriction.

Localities. In the Marshall sandstone at Marshall and Moscow.

This species differs from *O. Muensterianum* de Kon. (An. Foss., pl. xlviii, 1, 5), by its nearly transverse instead of very oblique septa.

ORTHOCERAS BARQUIANUM, n. sp.

Septate portion of shell more than 4¼ inches long; greater apical angle (i. e., the one formed by the sides which are not compressed) about 10°; transverse section an ellipse whose minor axis is to the greater as ·35 : ·50=1·43; septa somewhat oblique, making an angle of 8° or 10° with a transverse plane, most elevated near one extremity of the longer diameter; amount of concavity and position of siphon unknown; distance between the septa about one-fifth the greater axis at the same place. No surface markings evident from an examination of casts.

Locality. Near the light house at Pt. aux Barques in a hard bluish sandstone embraced in the shales of the Huron Group. (See Huron Group, (*c.*) of the preceding table.)

This species may possibly prove identical with the preceding, but its apical angle is somewhat less, its septa more oblique, its section more excentric, and its geological position considerably lower.

ORTHOCERAS MARSHALLENSE, n. sp.

Septate portion of shell more than 5·75 inches long; greater apical angle 6°; transverse section an ellipse whose axes are to each other as ·36 : ·61=1·69; ratio of interseptum to greater axis ·25 : ·45=1·8; septa very concave, the concavity equaling ·17; siphon on the minor axis, a little excentric. The cast gives no evidence of surface markings.

Locality. In the Marshall sandstone at Marshall.

This species is readily distinguished from its allies and associates by the great distance of the septa from each other, and the very gradual taper of the shell.

ORTHOCERAS CLINOCAMERATUM, n. sp.

The only specimen of this quite distinct form is only 1½ inches

in length, partly septate. It is a fragment of a shell about 3·3 inches long, having a major apical angle of 11°. The section is elliptical, with the minor axis to the major as ·24 : ·45=1·88. The first two septa are ·08 apart, and the ratio of this interval to the larger diameter at the same point is 6·25. The septa are deeply concave, oblique, and slightly sinuous, having one side ·12 in advance of the other. The greater diameter of the specimen is ·7 at one end and ·45 at the other.

Locality. In the Marshall sandstone at Hard Wood Pt. one mile S.W. of Pt. au Pain Sucre (called also Flat Rock Pt.) on the shore of Saginaw Bay.

ORTHOCERAS RETICULATUM.?

Phillips (Geology of Yorkshire, vol. ii, p. 238; pl. xxi, fig. 11).

The brief description given of this Carboniferous species does not disagree with the Michigan specimen in my possession. The figure agrees equally well. The fragment in question is 1¼ inches long, and shows only the exterior markings. Judging from the curvature of the specimen, it had a diameter of ·89 in the constriction between two rings, which are ·32 apart. The surface is marked by longitudinal and transverse striæ; the former are fine, raised, equidistant, 13 or 14 being embraced in the space of one-tenth of an inch; the latter consist of two sets —first, a set of irregular inequidistant, impressed striæ of which 3—6 occur in the space of one-tenth of an inch; secondly, a set of fine, regular, equidistant, filiform striæ, of which about 32 occur in the space of one-tenth of an inch. The latter give a finely moniliform appearance to the longitudinal striæ, but they are most distinctly seen after the exterior of the shell has been removed. Characters of the siphon and septa unknown.

Locality. In the Marshall sandstone at Marshall.

ORTHOCERAS sp.? *Lethiopianum Win.*

The only specimen seen of this species is a mere impression of the exterior, about an inch in length. It is made by a shell, apparently, with a circular section, and ornamented by a series of rounded rings, separated from each other by a concave depression about twice the width of the ring. The whole surface is further marked by distinct longitudinal striæ, about one one-hundredth of an inch wide. These seem to increase by interpolation of other striæ, which begin to make their appearance when the first ones are one and one-fourth hundredths of an inch wide, and look like a finer set of striæ alternating with the coarser. The diameter of the specimen, supposing the section circular, was about ·84 in the grooves between the rings, and the elevation of the rings is ·03. The distances of four successive rings, from center to center, are ·15, ·18, ·21 and ·21.

Locality. Marshall.

This impression agrees in form, dimensions and distance of rings with *O. dactyliophorum* de Kon. (An. Foss., pl. xvii, 2). But this species is described as having circular striæ without any longitudinal ones. It differs from *O. tenuilineatum* Sandberger (Verstein., Taf. xix, 7) by the greater approximation of the rings, and much more closely striated surface. This species, however, from the "Orthocerasschiefer" of Wissenbach, seems at least to be a close analogue. Our fossil is *perhaps* identical with *O. annulatum* of Hisinger, but I have no access to a description of that species.

NAUTILUS (TREMATODISCUS) PLANIDORSALIS, n. sp.
(non *N. planidorsatus* Portlock.)

Shell small, closely coiled, but the whorls not impressed; section angular, transverse diameter greater than the dorso-ventral. Dorsum perfectly flat and quite broad, marked by a strong longitudinal groove near each lateral boundary. From the dorsal area the surface bends abruptly down the dorso-lateral area, making with the dorsum a slightly rounded angle of 125°. The dorso-lateral area is half the width of the dorsum and is slightly concave. From the dorso-lateral area the surface bends regularly toward the umbilicus, but with an increasing radius of curvature. The umbilico-lateral area is marked by strongly raised, sharp, longitudinal striæ, which, under a lens, are seen to be decussated by fine, raised, transverse striæ, less rigidly direct than the former ones, more strongly marked where crossing the longitudinal striæ, and giving them a kind of moniliform appearance. Indications of longitudinal striæ exist over the whole surface, but the state of the specimen is unfavorable for their exhibition. The septa present a shallow, posterior sinuation in the middle of the dorsum, a similar anterior sinus on the dorso-lateral angle, and a slight posterior sinus on the lower portion of the dorso-lateral area.

Diameter of whorl ·76 (100); greatest transverse diameter of section ·43 (57); dorso-ventral diameter of section ·25 (33); greatest width of dorsum ·22 (29); greatest width of dorso-lateral area ·19 (25); distance of longitudinal striæ ·012 (1·6), giving 8 to one-tenth of an inch; distance of transverse striæ ·008 (1·0), giving 13 to one-tenth of an inch; greatest distance between the furrows on the dorsum ·18 (23); greatest distance between septa, measured on the dorsum ·14 (18).

Locality. Marshall.

The best specimen of this species in my possession is a fragment showing about half of one whorl from the septate portion of the shell. The species belongs to the group of angulated, widely umbilicated *Nautili* for which Messrs. Meek and Worthen have proposed the distinct subgeneric designation *Trematodiscus*

(Proc. Acad. Nat. Sci. Phil., June, 1861, p. 147; and this Jour., [2], xxxii, 174). *N. planidorsalis* bears an extremely close relationship to *N. digonus*, Meek and Worthen, from the Rockford "Goniatite bed" in Indiana (Proc. Acad. Nat. Sci. Phil., Oct., 1860, p. 470). It differs, however, by having a very *distinct* longitudinal groove along each lateral boundary of the dorsal area, and extending apparently the whole length of the shell, while *N. digonus* "is marked by two very obscure lateral depressions near the aperture." *N. digonus* also is "rounded regularly into the umbilicus," from the angle which bounds the dorsal area, while in *N. planidorsalis*, the "regularly rounded" area is separated from the dorsum by a dorso-lateral area which is concave.

NAUTILUS (TREMATODISCUS) TRIGONUS, n. sp.

Shell of moderate size, rapidly enlarging, marked longitudinally by three prominent, obtuse angulations—one dorsal and two dorso-lateral. The dorsal ridge is broadly convex, but the nature of the specimen does not permit me to ascertain whether or not the center is marked by a narrow groove. The dorso-lateral ridge is also regularly curved, and a small concave furrow separates it from the dorsal one. The slope from the dorsal to the dorso-lateral ridge makes an angle of about 65° with the dorso-ventral diameter. A broad, shallow lateral furrow succeeds the dorso-lateral ridge, and this is followed by a regular convexity descending into the umbilical cavity. The transverse diameter through this convexity is scarcely greater than that through the dorso-lateral ridges. The surface (of the cast) is smooth. The septa are rather deeply sinuous—a strong sinus turned backwards, occupying the dorsum, and a deep broad sinus, the side, these two being separated by an abrupt saddle whose apex rests upon the dorso-lateral keel.

Measurements, of a fragment forming less than half a volution, wholly septate. Dorso-ventral diameter ·45; transverse diameter about ·54; distance from dorsal to dorso-lateral ridge ·18; depth of dorsal sinus ·07; of lateral sinus ·14; interseptal distance on the dorsum ·17.

Locality. Marshall.

NAUTILUS (TREMATODISCUS) STRIATULUS, n. sp.

Shell small, rapidly enlarging, whorls not impressed, flattened on the dorsum on each side of the peripheral line, and thence rounded regularly into the umbilical expanse; transverse section somewhat elliptic, with the major axis corresponding to the transverse diameter of the shell. Septa slightly sinuous, one broad shallow sinus extending across the side and another across the dorsum. Surface finely and elegantly fluted longitudinally.

The largest fragment of this species is about half a volution,

wholly septate, and about 1·18 (100) across; dorso-ventral diameter at larger end ·41 (34); at smaller end ·34 (29); transverse diameter at smaller end ·38 (32); interseptal space on the dorsum ·16 (14); distance of striæ ·025, giving 4 in one-tenth of an inch.

Locality. Marshall.

The above species agrees with Hall's brief description of *Gyroceras gracile* (13th Rep. N.Y. Reg., p. 105), except in the abrupt undulation of the septa upon the dorsum. Though the position of the siphon is not satisfactorily ascertained, there are some indications that it is excentric though not marginal. The striately fluted surface recalls some species of *Gyroceras* figured by de Koninck.

NAUTILUS (TREMATODISCUS) MEEKIANUS, n. sp.

Shell small, rapidly enlarging, whorls not impressed, flattened across the dorsum, and even slightly concave along the peripheral belt; sides obtusely angulated by the flattening of the dorsum, the slope from the lateral angle being a regular curve into the umbilicus. Transverse section, in consequence of the dorsal furrow, somewhat cordate. Surface below the lateral angle, distinctly striate; above it, very obscurely so. Septa forming a very shallow sinus just below the lateral angle, and another, considerably deeper, across the dorsum.

Diameter of whorl (wholly septate) 1·25 (100); dorso-ventral diameter ·40 (32); transverse diameter ·40 (32); interseptal space on the dorsum ·18 (14); depth of lateral sinus ·04 (3); of dorsal sinus ·07 (6); distance of striæ ·04, giving two and a half in one-tenth of an inch.

Locality. Marshall.

The present species is closely related to the foregoing, but differs by a more depressed dorsum and coarser striation.

NAUTILUS (TREMATODISCUS) DISCOIDALIS, n. sp.

Shell of moderate size, flattened dorsally and laterally; lateral surface but slightly convex, its width nearly equal to the height of the shell; umbilical slope regularly curved, making an angle of about 120° with the side. Dorsum making a right angle with the side, but the character of the peripheral belt has not been seen. Cast longitudinally striated or grooved, indistinctly so on the sides, while a raised line gives prominence to the dorso-lateral angle. Septa forming a broad moderately deep sinus, which extends across the entire lateral surface; another one exists upon the dorsum.

A completed volution, wholly septate, measures 1·6 (100); dorso-ventral diameter ·56 (35); transverse diameter unknown, but the umbilical slope on one side is ·22 (14); lateral surface ·38 (24); distance of striæ on the umbilical slope ·028 (2),

which gives 3½ to one-tenth of an inch; depth of lateral sinus ·08 (5).

Localities. Marshall and Battle Creek.

NAUTILUS SUBSULCATUS (?)
Phillips (Geol. Yorks., ii, 233, pl. xvii, 18, 25).

The general outline of the transverse section is hexagonal, with well rounded angles. The sides are nearly plane, and parallel with the dorso-ventral diameter, and in the ventro-lateral region slope abruptly into the umbilical cavity, making an angle with the side, of about 65°. The lateral surface joins the dorsal at an angle varying from 74° to nearly 90°. At a little less (apparently) than half the transverse diameter of the cast, the dorsum shows a small rectangular carina, similar to the one represented by de Koninck in pl. xlix, fig. 4 *b*. The nature of the surface between this carina and the corresponding one on the opposite side of the peripheral line, has not been ascertained. The septa make a broad sinus coextensive with the lateral surface, and curve backwards again upon the dorsum. The angle of intersection with the sides shows that they are deeply concave. The inner whorl is somewhat impressed into the outer. External surface of cast is faintly marked by raised striæ crossing in lines parallel with the septa; and on the umbilical slope are seen traces of coarser longitudinal striæ.

Greatest dorso-ventral dimension ·8; width of lateral surface ·6; width of dorsal surface to carina ·27; width of ventral surface to impression of next inner whorl ·38; interseptal space on the dorso-lateral angle ·33; distance of transverse striæ ·02, giving 5 in one-tenth of an inch; distance of longitudinal striæ ·04, giving 2½ in one-tenth of an inch. A fragment of a larger specimen (wholly septate) must have belonged to an individual more than 4 inches across the outer whorl. In this, the lateral surface is ·8, and the umbilical slope ·47.

Locality. Marshall.

The transverse section of these forms is much less sharply angular than is shown by the figures of European authors, and the striæ seem to be coarser.

NAUTILUS INGENTIOR, n. sp.

Shell very large; whorls not impressed; transverse section an ellipse whose larger diameter corresponds to the height of the shell, the sides in some specimens being somewhat flattened. Surface (of cast) smooth; septa bent abruptly forward at their junction with the shell so as to meet it at an acute angle, slightly sinuous,—a broad shallow sinus occupying the superior lateral portion of the surface; dorsum not seen.

One fragment in my possession 3½ inches long, one-half sep-

tate, must have belonged to a specimen more than 7 inches across the outer whorl. The dorso-ventral diameter at the last septum is about 1½ inches; last interseptal space ·42 near the dorsum; depth of lateral sinus not more than ·10. Another specimen, wholly septate, supposed to belong to this species, though more rapidly curved, is 1·85 from the dorsal to the ventral side.

Locality. Marshall.

This species most nearly resembles the preceding, but differs in the absence of an angular section and the two sets of striæ. Among foreign species it recalls *N. ingens* Martin, but the section is less circular and the septa are more sinuous.

CYRTOCERAS TESSELATUM?
de Kon. (An. Foss., p. 529; pl. xlviii, 5).

A mere impression, undistinguishable from the above, seems to possess sufficient interest to deserve mention. It is one inch long and four-tenths broad, and could not have been made by any body which has heretofore come under my observation from the Marshall sandstone.

GONIATITES MARSHALLENSIS, n. sp.

Shell rather long, consisting of at least four whorls, the inner moderately impressed into the outer; transverse section varying from an ellipse of small excentricity to an oblong figure; surface smooth. Aperture and outer chamber not seen. Septa close, the lobes almost reaching the next posterior saddles. Dorsal lobe twice as long as its greatest width, clavate, with a long cuspidate acumination, at the extremity of which can sometimes be seen the outline of the minute siphon; first and second lateral lobes similar to the dorsal in form, but successively a little smaller and not acuminate; accessory lobe obtuse, half the size of the second lateral; ventral lobe profound. Dorsal and lateral saddles of form similar to the principal lobes, but regularly rounded at the extremity; first accessory saddle, half the size, the second, imperfectly developed.

Diameter of largest specimen seen 1·75 (100); major axis of transverse section ·59 (34); minor axis ·47 (27); length of dorsal lobe ·26 (15), of which the cusp is about ·07 (4); greatest breadth ·12 (7). Diameter of siphon ·015 (0·9).

Localities. The most abundant Goniatite in the feebly cemented, ferruginous sandstone at Marshall. Found also in a similar rock at Moscow, and numerous other localities in Hillsdale and Jackson counties. It occurs in the hard bluish calcareous sandstone at Battle Creek and in the hard purple sandstone at Hard Wood Pt., Saginaw Bay.

This Goniatite belongs to the group which embraces *G. Henslowi* Sow., *G. serpentinus*, *cyclolobus* and *mixolobus* of Phillips, but after careful study it seems sufficiently distinct from all. Its

closest European analogue is *G. mixolobus* Phil., from the Mountain limestone of the Isle of Wight and the "Posidonomyenschiefer" of Wiesbaden. Its nearest American analogue seems to be *G. Lyoni* Meek and Worthen (Proc. Acad. Nat. Sci. Phil., Oct., 1860), with which Prof. Hall's *G. Hyas* is identical (see 13th Rep. Regents N. Y., p. 102). The Michigan species, however, differs from the Rockford one in the addition of an accessory lobe and saddle, and in the dorsal lobe being broader and relatively longer. It is also somewhat more involute.

GONIATITES HOUGHTONI, n. sp.

Shell moderately long, whorls but slightly impressed, almost evolute; transverse section elongate-oval, abruptly rounded at the dorsal and ventral extremities, and nearly flat on the sides. Surface of shell apparently smooth. Septa rather remote. Dorsal lobe infundibuliform, attenuately acute, length equal to breadth of its base; first lateral lobe clavate, acute, twice as long as broad, reaching as far back as outer lobe; second lateral lobe of the same form as the first but somewhat larger; accessory lobe present, but not distinctly seen. Saddles all regularly rounded at the extremity; the dorsal, broadest at the base, the other two clavate and reaching one-third their length further forward than the dorsal.

Greatest diameter 1·75 (100); major axis of transverse section ·42 (24); minor axis ·21 (12); length of dorsal lobe ·12 (7); distance from tip to tip of two contiguous dorsal lobes ·24 (14).

Locality. Marshall.

Resembles the preceding but differs materially in the form of the dorsal lobe and the transverse section. It differs from *G. Lyoni* Meek and Worthen, in the greater relative length of the second lateral lobe and the first accessory saddle, as also in the more appressed transverse section. Its closest affinities are with *G. Henslowi* Sow., but differs in the more acute lateral lobes, and relatively longer lateral and accessory saddles.

GONIATITES ALLEI, n. sp.

Shell laterally compressed, the inner whorls impressed to the middle of the outer; umbilicus very small, not disclosing any of the inner volutions; aperture auriculate. Section (of an entire whorl) through the umbilicus, at right angles with the siphon, an elongated ellipse. Surface unknown, but the cast is marked along the dorsal region by minute, irregular, revolving striæ. Dorsal lobe wanting or too minute to be detected in sandstone casts. First lateral lobe acute, terminating at an angle of about 60°; second lateral lobe extending as far back as the first, its apex in the form of a low gothic arch, body of the lobe campanulate, equilateral. Dorsal saddle parabolic, not

distinctly indented at the apex by a dorsal lobe; lateral saddle nearly twice as long as the dorsal, its apex rounded and slightly turned toward the umbilicus, its width equal to its height, size a little larger than the second lateral lobe; accessory saddle projecting nearly as far forward as the lateral, but twice as broad, and flatly rounded anteriorly. Ventral lobe small, but profound, and separated on each side by a narrow, rounded saddle from another small lobe upon the ventral surface of the whorl.

Greatest diameter of shell as far as seen ·72 (100); width of aperture between the auriculations ·21 (29); distance from tip to tip of two dorsal lobes nearest the aperture ·15 (21); distance between striæ on dorsal surface of cast ·004.

Localities. Marshall and Jonesville.

The side view of this species resembles that of *G. uniangularis* Conrad, but the details of the septa are materially different. It has affinities with *G. carinatus* Boyr., and *G. lamed*, var. *complanatus* Sandb., from the "Cypridinenschiefer" in Nassau, but differs from both in its closed umbilicus, the want of a dorsal lobe, and the presence of an accessory saddle, which, in our species, is as prominent as the lateral one.

Goniatites Oweni,
Hall (13th Rep. N. Y. Reg., p. 100).

A Goniatite common in the sandstone which is the prolongation of the beds at the grindstone quarries, on the shore of Lake Huron, in the vicinity of Pt. aux Barques, presents all the essential characters of *G. Oweni*. Comparing it however with figures and descriptions of this species, as well as with specimens from Rockford, Ind., our fossils are somewhat more compressed laterally, the septa are more approximated, and the lateral lobes lie along the middle of the lateral surface, instead of considerably nearest the dorsal region.

Prof. Hall's var. *parallela* (*parallelus?*) is also distinctly represented at the same localities, but it is to be remarked that in this variety the umbilicus is *more* open instead of *less* so.

Goniatites Shumardianus, n. sp.

Shell of moderate size, laterally compressed; dorsal surface narrowly rounded, dorso-lateral surfaces but slightly convex, making with each other an angle of about 27°, abruptly inflected into the moderately open umbilicus, which reveals a small portion of two or three preceding whorls; greatest width of transverse section (near the umbilicus) two-thirds the dorso-ventral dimension. Septa rather remote. Dorsal lobe not satisfactorily defined, but apparently simple, sharply acute, with a length about equal to the breadth at the base; first lateral lobe extending as far back as the dorsal, acute, but with a broad base; sec-

ond lateral lobe wanting. Dorsal saddle parabolic; lateral saddle very broad, and extending one and one-fourth times as far forward as the dorsal, and having its umbilical branch much more abrupt than the lateral one.

Greatest diameter of shell seen 1·02 (100); greatest transverse diameter of section ·33 (32); dorso-ventral dimention ·49 (48); distance from tip to tip of two dorsal lobes nearest the aperture ·23 (23); greatest width of umbilicus ·23 (23).

Locality. From the gritstones in the vicinity of the quarries near Pt. aux Barques.

This species is closely related to *G. Allei*, but is laterally more compressed, with a sharper dorsum, and unlike that, has but one lateral lobe.

GONIATITES PROPINQUUS, n. sp.

Shell of moderate size, closely involute, with a closed, slightly indented umbilicus; slightly compressed, with a well rounded dorsum, and moderately convex sides making with each other an angle of about 10°. Septa rather remote. Dorsal lobe of medium size, infundibuliform, obtuse; lateral lobe extending half its length behind the dorsal, infundibuliform, slightly rounded at the apex, and with a base equal to the height; second lateral lobe wanting. Dorsal saddle parabolic; lateral saddle somewhat semicircular, but most convex anteriorly.

In the only specimen seen, the dorso-ventral dimension is ·65; the greatest diameter of transverse section (close to umbilicus) is ·43.

Locality. From the gritstones in the vicinity of Pt. aux Barques with *G. Shumardianus* and *G. Oweni.*

Closely related to *G. Shumardianus*, but has a more broadly rounded dorsum, with sides more nearly parallel and wants the open umbilicus. The lateral lobe is also much more produced posteriorly and both lobes are probably a little less acute.

A Goniatite having the general form and appearance of the three preceding species has been found at Marshall, in fragments which are marked by occasional sinuous transvere furrows, and while its single lateral lobe separates it from *G. Allei*, its more rounded dorsum differs from *G. Shumardianus.* Should it prove distinct it may appropriately be called *G. sulciferus.*

GONIATITES SINUOSUS?
Hall (Geol. Rep. 4th Dist. N. Y., p. 245).

I have in my possession several specimens of an involutely coiled shell which cannot be distinguished by the aid of Prof. Hall's figure and brief description from *G. sinuosus.* At the same time some doubt exists in reference to the Goniatitic character of my specimens. The septa are very imperfectly shown, but by comparing different individuals, it appears that they form

a broad (Nautiloid?) sinus, convex *anteriorly*, on the superolateral surface, and another of about the same size on the inferolateral surface. A Goniatitic lobe may connect these two saddles, but it cannot yet be discerned. My specimens are sharply striated transversely in the umbilical cavity. In size and proportions they correspond exactly with the New York species, which occurs in the Portage Group.

GONIATITES PYGMÆUS, n. sp.

Shell very small, globose, closely involute, with a minute, perforated umbilicus. Whorls divided into quadrants by apertural constrictions. Dorsum regularly rounded, sides convex. Septa moderately angulated; dorsal lobe relatively broad, obtusely rounded, with indications of a slight indentation at the apex; lateral lobe shallow, acute, infundibuliform; dorsal and lateral saddles broad, shallow, circularly curved. Surface (of cast) perfectly smooth.

A sole specimen, which seems to embrace a portion of the last chamber is ·25 in diameter; height of section ·13; transverse diameter ·13.

Locality. Supposed to be Battle Creek.

This interesting little species externally resembles *G. planilobus* Sandb. (Verstein., Taf. x, 6, 7), but the septa are more angulated. It differs from *G. striolatus* Phillips (Geol. Yorks., ii, pl. xix, figs. 14–19), by a much smaller umbilicus, larger dorsal lobe and saddle, and much smaller inferior lateral lobe, and (in the cast) by the absence of striæ.

University of Michigan, Ann Arbor, Jan. 30, 1862.

ART. XXXVI.—*On Methylamine;* by M. CAREY LEA.

(1.) *Production and Separation of Methylamine.*

IN a previous paper I have pointed out that ammonias in which hydrogen is replaced by methyl are obtained by the action of nitrate of methyl upon ammonia at ordinary temperatures.* Nitrate of methyl, obtained by the distillation of methylic alcohol with nitric acid and urea, is placed in well stoppered bottles filled only about one quarter, together with a little more than its own bulk of thoroughly saturated aqueous ammonia, and is left till the nitrate of methyl disappears, or until only a few brown oily drops remain, a reaction which requires from three to six days, according to the temperature. The liquid is then distilled with caustic alkali and the gaseous products are conducted into water.

In this solution we should by analogy expect to find ammo-

* This Journal, March, 1862.

nia, methylamine, dimethylamine and trimethylamine, and it remains to separate these bases. This is a matter of extraordinary difficulty, much surpassing that of the separation of the ethyl bases. In the ethyl series the bases differ from each other and from ammonia by C_4H_4, whereas in the methyl series the successive terms acquire the addition of C_2H_2 only. Naturally therefore we must look for greater similarity in character and corresponding difficulty in separation. Accordingly, the methods which give such satisfactory results with the ethyl-ammonias, fail entirely with the methyl bases. Ammonia cannot be separated from them by a difference in the solubility of the sulphates in alcohol: when the mixed solution is neutralized with sulphuric acid and exhausted with alcohol, little or nothing is removed by it. Nor can the separation be effected by means of picric acid, although that substance may be used in one particular case mentioned below.

This problem I have as yet been able to resolve only in part. Two steps I have accomplished:—first, the complete removal of the ammonia from the mixed methyl bases, and second, the isolation of the methylamine in a state of purity. The separation of the more substituted bases still remains to be accomplished.

It is however, satisfactory to have a process for obtaining perfectly pure methylamine without resorting to the troublesome reaction of the cyanate of methyl, and that much has been effected. After the compound ether has been completely decomposed by the ammonia, the contents of the bottles are to be distilled with caustic alkali or lime. The solution of the mixed bases and of ammonia is to be exactly neutralized with oxalic acid and the water driven off as far as possible by being heated over the water-bath. The resulting mass is transferred to a flask, and boiled a few minutes with a large quantity of alcohol of density 42° B., and after cooling and standing some hours, it is filtered. The whole of the ammonia remains as oxalate upon the filter. The filtrate by spontaneous or gentle evaporation separates into two layers. The lower, which is much the least in quantity, becomes very soon crystalline, indeed this change takes place so rapidly that the fluid stage may easily pass unnoticed. More oxalate of methylamine remains in the mother liquid and separates on further evaporation.

After the fluid has crystallized, the resulting pearly white laminæ are purified by boiling with absolute alcohol, or with a mixture of equal parts of alcohol of 42° B. and ether, and this is repeated three or four times, allowing a thorough cooling to take place between each operation. The oxalate of methylamine finally crystallizes out quite pure, and methylamine may be obtained from it directly by distillation with caustic alkali. But the distillation is extremely unpleasant, exhibiting the phenomenon of percussive ebullition to such a degree as to endanger the whole

apparatus, and to drive the liquid out of the Woulfe's bottle in strong jets through the safety tube. It is therefore advisable to treat the oxalate with nitrate of baryta or chlorid of barium, leaving them in contact for a day, to evaporate the filtrate and then distill. I give the preference to the nitrate of baryta, because the nitrates of the ammonias distill more quietly than any of the others of these salts.

The methylamine thus obtained was converted into chloroplatinate and analyzed.*

1·0105 grms. gave of Pt, - - -	·4216	
This corresponds to, per cent, - - -		41·72
Theory requires for $\left.\begin{matrix} C_2H_3 \\ H \\ H \\ H \end{matrix}\right\}$ NCl, $PtCl_2$, -		41·62

The residue after the greater part of the oxalate of methylamine had crystallized out, was evaporated, exhausted with absolute alcohol, treated with nitrate of baryta, distilled with caustic soda and neutralized with picric acid. From this solution there crystallized out beautiful amber-colored bevelled prisms and hexagonal plates greatly resembling the picrate of ethylamine and apparently isomorphous with it. These were converted into chloroplatinate and analyzed with the following result.

·7265 grms. chloroplatinate gave of Pt, -	·3025	
This corresponds to, per cent, - - -		41·65
Chloroplatinate of methylamine contains, -		41·62

The substance was therefore picrate of methylamine.

The residue appeared to be a mixture. Analyses of different portions, from different crystallizations gave respectively 39·85, 40·14, and 40·23 per cent of platinum in the chloroplatinate, nor could any satisfactory means of separation be found.

Reactions of Methylamine.

Many of the reactions of methylamine have been already described by its discoverer, M. Wurtz. To these may be added the following.

Cerium, protochlorid,	A white precipitate insoluble in an excess of the precipitant.
" nitrate of protoperoxyd,	Dirty white, insoluble in excess of precipitant.

* It is scarcely necessary to observe that if platinum salts are recrystallized the results of their analysis cannot be taken as a proof of the accuracy of the mode of separation used. In the analyses here published care was taken to use in all cases an excess of bichlorid of platinum, and to include the whole precipitate in the analysis.

Zirconium, sulphate of zirconia,	White, insoluble in excess.
Aluminium, alum,	A white precipitate which redissolves in an excess of the precipitant.
Antimony, terchlorid,	A red brown precipitate insoluble in excess of precipitant.
Glucinum, sulphate of glucina,	A white precipitate insoluble in excess of precipitant.
Molybdenum, protochlorid,	No precipitate.
" bichlorid,	Reddish precipitate insoluble in excess of precipitant.
Palladium, protochlorid,	Abundant flesh-colored precipitate, insoluble in excess of precipitant.
Ruthenium, sesquichlorid,	Brown precipitate, insoluble in excess of precipitant.
Platinum, protochlorid,	No precipitate.

In describing the reactions of diethylamine I pointed out* that the remarkable property of dissolving alumina, hitherto considered as characteristic of ethylamine, amongst the ammonias, was shared by diethylamine. It now appears that it is possessed also by methylamine, and it would not be surprising if it was found to extend to the other methyl and ethyl bases, and even to the bases containing other alcohol radicals, a point which I propose hereafter to examine.

The deportment of methylamine towards solutions of protochlorid of molybdenum is characteristic, and differs from that of ammonia, ethylamine and diethylamine.

Methylamino-chlorid of Palladium.

When aqueous methylamine is added in excess to solution of protochlorid of palladium, or to a solution of the following salt, at the first moment no precipitation takes place, but in a few moments a quantity of flesh-colored needles are formed. These were dried over sulphuric acid and ignited.

·2049 substance gave metallic palladium ·0969.

From which we find:—

		Calculated.	Found.
2C,	12	9·32	
5H,	5	3·88	
N,	14	10·88	
Pd,	53·3	41·38	42·45
Cl,	35·5	27·56	
HO,	9	6·98	
	128·8	100·00	

leading to the formula $C_2H_5\widehat{N}PdCl+HO$.

* This Journal, Jan., 1862.

The palladium is a little in excess because with the small quantity of material at command, it was impossible to wash out the not entirely insoluble precipitate thoroughly, without too great a loss.

Chloro-palladite of Methylamine.

When methylamine is added, not in excess, to an acid solution of protochlorid of palladium, or when the foregoing salt is treated with an excess of the same acid solution, a deep brown red liquid is obtained, which by concentration yields beautiful brown red laminæ, very soluble in water and in alcohol. The quantity at command was insufficient for analysis, but judging from analogy, their constitution must be

$$C_2H_6NCl, PdCl.$$

Picrate of Methylamine.

This is a very beautiful salt. It crystallizes in bright yellow laminæ grouped in fine arborescent clusters, or by somewhat slower crystallization, in amber-colored bevelled prisms and hexagonal plates. Heated on platinum foil it deepens in color, melts to a clear red liquid apparently without decomposition, and when the heat is further raised, burns with a vivid white light leaving a carbonaceous residue. It is moderately soluble in water and in alcohol.

Other combinations of methylamine will be described at a future time.

ART. XXXVII.—*On Prof. J. Hall's claim of Priority in the determination of the Age of the Red Sandrock Series of Vermont;* by E. BILLINGS.

IN an article published in the last January number of this Journal (this vol., p. 107) Prof. Hall states that in 1844 and 1845 he made several sections from the Hudson river and Champlain valleys eastward, and that he then recognized the Potsdam sandstone at several localities both in Vermont and Massachusetts. It is very true that he did; but his paper is so written, that any person unacquainted with the facts would, upon reading it without due caution, understand him to mean that the rock which he identified as the Potsdam was the Red Sandrock Series. The object of this communication is to supply several facts not mentioned by Prof. Hall, and which if read in connection with his paper will throw some additional light upon the subject. Apart from all personal considerations, I hold that this investigation is

of such great importance that its history ought to be correctly worked out now while the facts are still fresh in the memory of all the parties concerned.

In order that what follows may be more clearly understood, it seems necessary to premise that the geologists of Vermont have always distinguished two great arenaceous formations in their country differing from each other in aspect and geographical position. One of these, the "Granular" Quartz Rock constitutes a narrow belt lying along the western base of the Green Mountains in the southern half of the state. In the recently published map of the Vermont Survey there are two outliers of this formation represented as occurring further north,—one in the county of Chittenden, completely surrounded by the formation now called the "Talcose" conglomerate, and another still further north lying alongside of the Georgia slate. This granular quartz rock is the formation recognized by Prof. Hall in his sections as the Potsdam sandstone, but it is not the formation always known under the designation of the Red Sandrock Series. This latter, and not the former, is the rock to which the papers of Mr. Hitchcock and myself relate. On the Vermont map and in Prof. Hall's sections, these two formations are indicated by different colors and distinguished by different names. Emmons considers the granular quartz rock to be an older deposit than the Potsdam. Prof. H. D. Rogers in 1840 examined it and came to the conclusion that it was the Potsdam itself.* The Red Sandrock Series forms an irregular belt along or near the shore of Lake Champlain, running the whole length of the lake and entering Canada near Phillipsburgh. The age of this rock has always been disputed, Dr. Emmons holding on one side that it was partly of the age of the Calciferous sandrock and partly Potsdam sandstone, while those who were opposed to his views on the Taconic System, held that it was a more recent formation. I believe it is now proved that Dr. Emmons' view is the correct one, and Prof. Hall's paper would lead us to suppose that he arrived at the same conclusion fifteen years ago. But the only documents that I can find which give us any clue to his original opinion are the sections to which he has made allusion, and the letter to Prof. Adams pointed out by Mr. Hitchcock. These do not prove that he agreed with Emmons, but rather that he was of a contrary opinion. The sections it appears were engraved but never published. I have however succeeded in procuring several of them and shall describe such portions as cross the Red Sandrock. By comparing Prof. Hall's paper it will be seen that he has omitted to make any allusion to these portions of the sections, the reason being, no doubt, that if he had done so, the reader would arrive

* See Proc. Am. Philosoph. Soc., vol. ii, p. 3, 1841, and also this Journal 1st ser. vol. xlvii, p. 151, where Prof. Rogers's views are given at length.

at a different conclusion from that intended to be induced by the learned Professor.

The first of these sections crosses Lake Champlain from Plattsburgh, traversing Hero Island and the towns of Milton and Fairfax. The only place where it crosses the Red Sandrock, is near St. Albans, and it must therefore pass through the Georgia slates very near the locality of the far-famed primordial trilobites. According to the new map of the Vermont Survey, above quoted, there is here a strip of Red Sandrock two miles wide, lying along the shore of the lake. This is followed by four or five miles of the Georgia slate and then about two miles of granular quartz rock. Prof. Hall's section represents the latter as the Potsdam sandstone, but the Red Sandrock and all the Georgia slates are called "*Trenton and Lower Limestones of the Mohawk Series.*" His section is colored,—the Potsdam, pink, and his so-called Trenton, blue. The remainder of this section does not cross any of the rocks under discussion and need not be noticed here.

This locality must always be looked upon with much interest, as the trilobites which have brought about so great a change in the opinions of some of our best physical geologists were here first discovered. Prof. Hall placed these trilobites and the slates in which they were found in the Hudson river group, but as soon as he saw that this view was incorrect, he denied that he had ever examined this part of the country at all, and at the same time gave the public to understand that he had been induced to refer this Primordial Fauna to the top of the Lower Silurian by Sir W. E. Logan. He says that "after the descriptions had been printed and *a few copies distributed*,"* he learned that Sir W. was at that time actually investigating the rocks of that part of Vermont. He then delayed the final publication till the meeting of the American Association (in Springfield) and there showed him the descriptions and obtained his authority for the addition of the note in which Sir W.'s opinion is stated.† He says, "left to palæontological evidence alone, there never could have been a question of the relations of these trilobites which would at once have been referred to the primordial types of Barrande." "Sir William Logan" he says, "yields to the palæontological evidence," and says "there must be a break." "He gives up the evidence of structural sequence which he had before investigated and considered conclusive; *and having heretofore relied upon the opinion* of the distinguished geologist of Can-

* May we be permitted to ask, to what formation are the Georgia slates referred in these "few copies" which were distributed before he obtained Sir W. E. Logan's opinion? Are they referred to the Hudson river group or to Dr. Emmons's Taconic System?

† Does he not here admit that the 12th Regents Report was altered by him in an important matter after the date of its publication.

ada *in regard to a region of country to which my own examinations had not extended*, I have nothing left but to go back to the position sustained by palæontological evidence."* As I understand this, it means that he never examined the country in the neighborhood of the Georgia locality of trilobites, and if he did not, then this section must have been compiled from the observations of of some one else. At all events the section proves very clearly that at the time he drew it up he did not know the age of the Red Sandrock Series.

The next section crosses the state of Vermont from Burlington eastward. On the Vermont map the Red Sandrock is here three miles wide along the lake shore. On the east side of it is a belt of Eolian limestone, also about three miles in width. The whole of this is laid down on Prof. Hall's section as "*Trenton and Lower Limestones of the Mohawk Series becoming metamorphic.*" He represents the rock as being all of this kind from the lake shore half way to the Green Mountains. A few beds of the Potsdam sandstone are then indicated as coming out from under the so-called Trenton limestone in the town of Willston. In the Vermont map there is a small outlier of granular quartz rock just about this locality, lying partly in Willston and partly in Hinesburgh, but it is totally separated from the Red Sandrock. The remainder of this section does not cross any of the rocks under discussion.

The above two sections are on plate 1. I have not been able to procure plate 2, and do not know what its contents are. I have plate 3, on which are engraved three sections. The first of these crosses from Whitehall in New York, to the Green Mountains. It shows an exposure of both the Potsdam and Calciferous formations at Whitehall. There never was any dispute as to the age of the rock at this locality. It has always been referred to the Potsdam and Calciferous, but never identified (except by Dr. Emmons) with the Red Sandrock. On this section all the slates between Whitehall and the Green Mountains are referred to the Hudson River Group. But according to the Vermont map they are the Georgia slates and are therefore the Taconic slates of Dr. Emmons, which lie below the base of the Lower Silurian, as that formation was originally limited. On this section therefore is engraved precisely the same mistake with respect to the age of the rocks, as that which was published in the 12th Regents' Report, with regard to the Georgia slates. The granular quartz rock lying at the base of the Green Mountains, is called "Potsdam," as it is in the other two sections. The other three sections do not cross any of the Red Sandrock.

* See Prof. Hall's letter to the Editors of this Journal, [2], xxxi, p. 220, March, 1861. In his last paper he seems to give the late Prof. Adams credit for having originated the mistake with regard to the Vermont rocks.

The only comment that need be made upon all of the above, is that at the time Prof. Hall prepared the sections to which he has appealed, *he did not know the age of the Red Sandrock*, but merely supposed it might consist of the Trenton, Black River and Chazy (the limestones of the Mohawk series) in a metamorphic condition. In no place where the Red Sandrock occurs is there a vestige of the Potsdam laid down in his sections. The fact that he recognized the Potsdam in other places avails him nothing in this discussion.

I have also lately procured the Geological Report containing the letter referred to by Mr. Hitchcock.* It is published as an appendix to the Report. The following is a copy of it:

"C."

"*Letter from Professor James Hall, on certain fossils in the Red Sandrock of Highgate.*"

"Albany, N. Y., September 17th, 1847.

My Dear Sir:—I have only now received your letter of the 10th instant, on my return from a geological excursion. I have examined the fossils and, as far as I can determine, they are all of the central portion of the buckler of a trilobite with a prominent narrow lobed glabella. The cheeks have been separated at the facial section, so that we have not the entire form of the head. The course of the facial section indicates that it terminated on the posterior margin of the buckler, and the glabella is narrower in front than behind — these two characters are inconsistent with Calymene, Phacops or Asaphus, the common genera, (as well as with several other genera) of our strata, but they belong to Conocephalus and Olenus. I am inclined to regard this fragment as part of a Conocephalus, of which I have not before detected a fragment in our rock. From its isolated character, therefore, I am able to infer little regarding its real geological position. The form known to me most like this one, is in the Clinton group of this state. I regret that more species could not have been found, or that some form in the preceding strata could not be obtained to compare with the others already known.

The meagre information of the two known species of Conocephalus is likewise an objection to any geological inference from the discovery of a species. All we know is that they are found in Graywacke, in Germany, or elsewhere, and the position of the Graywacke is too dubious and ubiquitous to be of any importance in such a case.

I regret exceedingly that I am able to give only this meagre and unsatisfactory information, and also that I have not had the satisfaction of seeing the locality.

I shall see you in Boston next week, if I am able to go there, and will there reply more fully to the other part of your letter respecting New York fossils.

I have prepared nothing for our meeting but am coming to see what others do. I am very sincerely yours, &c., JAMES HALL.

Prof. C. B. ADAMS."

* This Journal, [2], xxxii, p. 454.

"[Two specimens only have been obtained of a shell, which resembles Atripa Hemispherica, of the Clinton group of the New York system. Prof. Hall informs me that he is disposed to assign both the Clinton group and the Medina sandstone to one geological period.—C. B. A.]"*

This letter of Mr. Hall's proves the same thing that is established by his sections, i. e., that he was quite ignorant of the true age of the formation. The views of Prof. Adams on the age of the Red Sandrock must have been well known to all those engaged in the Taconic discussion, and most especially to Prof. Hall who has always been Dr. Emmons's leading opponent. The officers of three different geological surveys, namely, the survey of Vermost under Prof. Adams, the survey of Canada under Sir W. E. Logan, and the recent survey of Vermont under President Hitchcock, have at different times all placed the Red Sandrock in the horizon indicated in the above letter. They were all in constant communication with him, and in the Introduction to the 3d vol. of the Pal. N. Y., he claims priority over them all in the authorship of the very same views which he now seeks to charge upon them. In this last named work (p. 14) he says that the Hudson river group "may include all the beds from the Trenton limestone to the Shawangunk conglomerate." By this latter is meant the Red Sandrock. In the next sentence he says, "from the metamorphic slates of this group on the western slope of the Green Mountains in Vermont we have three or more species of trilobites which are of much interest, being representatives of a genus but little known in this country." These trilobites are no doubt the fossils of the Georgia slates which are called Trenton limestone in his sections. On page 15, he says:

"The opinions advanced by the writer (meaning himself) in 1844 and 1845, and published in the first volume of the Palæontology of New York, relative to the age of the rocks composing the metamorphic belt on the east side of the Hudson river, and including the principal part of the Green Mountain range, has been fully confirmed by Prof. Adams in the Geological Reports of Vermont. A re-examination of some portions of the same belt has added fresh evidence of the age of the formations, so far as included in Eastern New York, Western Massachusetts and Vermont."

He then gives Canada credit for contributing a good deal towards the confirmation of his views and closes at the foot of page 16 with "Geological structure therefore, and chemical and *palæontological* evidence all unite in proving the age of these deposits."

I shall only add that all the physical geologists engaged in this investigation with whom I have conversed on the subject,

* See "Third Annual Report on the Geology of Vermont." By C. B. Adams, State Geologist, &c., p. 31, 1847. Appendix C.

have assured me that Prof. Hall never gave them the least hint that the fossils proved a more ancient horizon than that indicated by the apparent attitude of the strata, but on the contrary always spoke of them as characteristic of the Hudson River group.* And so perfect was their confidence in the soundness of his opinion that it never occurred to them that he could be wrong, especially as every physical arrangement of the strata seemed positively to confirm his views. It was his duty to keep the fact always prominently before their minds that there was an antagonism between the physical and palæontological evidence. What the results would have been had he adopted this course is now apparent. As soon as the mist of erroneous palæontology was dispelled, the structure seen under a new light presented no difficulty of importance, and moreover many of the minor points which seemed to be very perplexing are now seen to be perfectly explicable.

Montreal, March 11th, 1862.

* The fossils alluded to here are those of the slates at Bald Mountain in New York published as Hudson River in the 1st vol. of the Pal. N. Y. in 1847, and also those of the Georgia slates in Vermont. Prof. H. never mentioned the *Conocephalites* to the Canadian Surveyors. The whole question has always rested on the correctness of the determination of the first of these, which are the original Taconic fossils on which Emmons depended. If Prof. Hall had been correct with regard to these, then all the Physical Geologists who sided with him would have been right as to the age of the Sandrock. The formation would be about the age of the Medina Sandstone. In fact he could not call the Red Sandrock Potsdam without contradicting in the most positive manner his own views as published in his first volume. Of course the Physical Geologists were well aware of Dr. Emmons opinions but nothing could shake their confidence in Prof. Hall. Even after the primordial aspects of the Georgia trilobites were pointed out, and for several months after the discovery of the Quebec fossils, they were very unwilling, as I know from my own experience, to believe that he could be wrong, especially as the physical structure seemed to confirm his views in the most remarkable manner. E. B.

Art. XXXVIII.—*Influence of Diffraction upon Microscopic Vision;* by Dr. M. C. White.

[Read before the Connnecticut Academy of Arts and Sciences, Jan. 15th, 1862.]

In a former communication to the Academy, and in an article on spontaneous generation, I assumed the limit of microscopic vision to be the same as the limit of resolvability of a series of lines,* or that objects could be seen no smaller than $\frac{1}{8000}$ of an inch. According to Hartung, "Das Mikroskop," &c., p. 784, it appears that with a microscope of 94° aperture made by Amici in 1848, an opake round object could be seen as small as $\frac{1}{4700}$ of a millimetre in diameter ($\frac{1}{11930}$ inch) and a thread-form object could be seen which was only $\frac{1}{4300}$ m.m. ($\frac{1}{10920}$ inch) in diameter. These objects it appears were reduced images formed by reflection in bubbles of air or other fluid. The dimensions of these images were calculated, but not directly measured. It will be shown hereafter that the calculation of these dimensions are probably liable to considerable errors.

Mr. W. S. Sullivant of Columbus, O., has kindly supplied me with a single experiment of the same kind, made with the best American objectives. A microscope was adjusted with a $\frac{1}{12}$ inch object glass, and a $\frac{1}{3}$ inch objective to act as an achromatic condenser. A globule of mercury $\frac{1}{2000}$ of an inch in diameter, was placed about 3 inches from the $\frac{1}{3}$ condenser, in which position it was determined by previous experiment that an image, reduced 75 diameters, would be formed in the common focus of the condenser and the $\frac{1}{12}$ objective by which the reduced image was to be viewed. The reduced image of the globule of mercury was therefore calculated to be only $\frac{1}{150000}$ of an inch in diameter. This image was clearly seen in the compound microscope with the $\frac{1}{12}$ objective with a light (by no means the best) from a northern window and an overcast sky. It will be understood that the diameter of this reduced image of a spherical opake object, was not quite as small as the breadth of the alternate lines of light and darkness seen when the lines of Nobert's test of $\frac{1}{112}$ in. were resolved by the same observer;† for either the lines themselves or the intervals between the lines must have been as narrow as $\frac{1}{224000}$ in. Now if single lines or dots can be seen much smaller than similar lines or dots that can be resolved when arranged in a series, what is the cause of this difference and what is the impediment that prevents the resolution of a series of lines like the bands Nos. 29 and 30 of Nobert's test?‡ These and many other

* This Journal, [2] xxxii, 9.

† This Journal, [2], xxxi, 14.

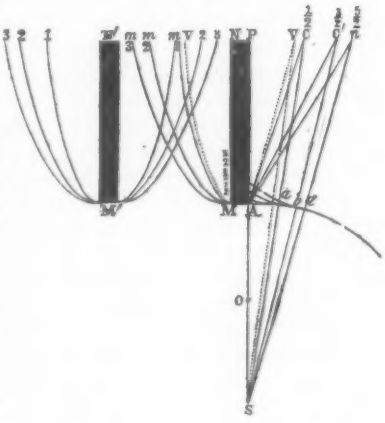
‡ This Journal, [2], xxxi, 14.

curious phenomena seen in the microscope, have induced me to investigate the influence of diffraction upon microscopic vision.

In order to show the influence of diffraction upon the appearance of objects seen in the microscope, the following mathematical analysis has been copied from Daguin's *Traité Élémentaire de Physique* with such modifications as its application to the microscope require.

In fig. 1, let M A N P and M′N′ be transverse sections of lines cut in a plate of glass of which the upper surface is in the plane N′, N P, *n*. These lines are to be viewed from above, and are illuminated by light from below emanating from S. According to the well known theory of diffraction, the light which strikes the opake object, A, radiates from that point in every direction, as from a new centre of illumination. If now any point, C, is taken at such a distance from P that the path S A C is greater than the distance S C by one-half the length of a vibration of light, the rays A C and S C will interfere and produce darkness at that point. The same thing will occur at C′ when S A C′ exceeds S C′ by three half vibrations, and so on for other points where the two paths differ by an odd number of half vibrations, the successive dark fringes being designated as of the 1st, 2d, 3d and *m*th orders respectively. If we consider the dark fringe *n* of the order *m*, and let λ represent the length of a vibration of light, it is evident we shall have $An-dn=(2m-1)\frac{\lambda}{2}$. Subtracting this equation from the equation $Sd=SA$ we have $Sd+dn-An=Sn-An=SA-(2m-1)\frac{\lambda}{2}$.

1.



The second member of this equation being constant whatever be the distance, AP, the trajectory of the fringe forms one branch of an hyperbola whose foci are at A and S. To obtain the equation of this hyperbola in a form convenient for discussion let $SA=2C$, $AP=x$, $Pn=y$, and then seek the values of 2A and 2B, the axes of the curve.

We first take $2A=Sn-An=2C-(2m-1)\frac{\lambda}{2}$, whence,

$A^2=C\left(C-(2m-1)\frac{\lambda}{2}\right)$ neglecting the term which contains λ^2.

The known relation $B^2=C^2-A^2$ gives,

$$B^2=C^2-C\left(C-(2m-1)\frac{\lambda}{2}\right)=C(2m-1)\frac{\lambda}{2}.$$

The equation of the hyperbola referred to its centre and to its axes is therefore,

$$C\left(C-(2m-1)\frac{\lambda}{2}\right)y^2-C(2m-1)\frac{\lambda}{2}x^2=-C^2\left(C-(2m-1)\frac{\lambda}{2}\right)(2m-1)\frac{\lambda}{2}$$

or $Cy^2-(2m-1)\frac{\lambda}{2}x^2=-C^2$; omitting the terms which contain λ^2 and neglecting $(2m-1)\frac{\lambda}{2}$ as too small to be considered when added to the quantity C. If we desire to refer the curve to the point A, as its origin we have only to replace x in the formula by $x+C$ when the equation becomes,

$$\left(C-(2m-1)\frac{\lambda}{2}\right)y^2=(2m-1)\frac{\lambda}{2}(x^2+2Cx) \quad \text{or,}$$

$$(1.) \qquad y=\sqrt{(2m-1)\frac{\lambda}{2}(x^2+2Cx)\div C}$$

considering as before $(2m-1)\frac{\lambda}{2}$ very small as compared with C.

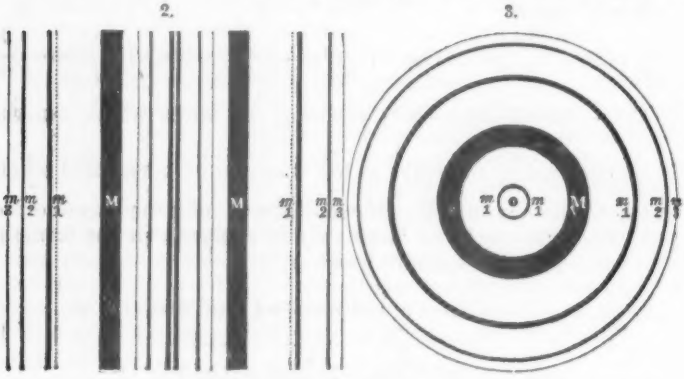
If we consider only the first fringe $m=1$ and the equation becomes,

$$(2.) \qquad y=\sqrt{\frac{\lambda}{2}(x^2+2Cx)\div C}.$$

Considering these equations it is evident that the value of y, or the distance of a dark band produced by diffraction from the real line which produces it, will be directly proportional to the value of the square root of λ. Now as the length of a wave of violet light is least and a wave of red is greatest, and the waves of other colors are of intermediate lengths, it is evident that the dark band produced by diffraction will consist of all the colors of the spectrum, the violet being nearest and the red most distant from the true shadow or image of the object. The dotted lines SV and AV, fig. 1, show the paths of the rays that produce a violet band, and MV shows the trajectory of the curve of violet light on the other side of the opake object. Mm_1, Mm_2, and Mm_3 show the trajectories of the first, second and third orders of fringes.

If M and M, fig. 2, represent lines ruled upon glass seen in the microscope from above, the other parts of the figure show the positions of the spurious lines or series of colored fringes of the first, second and third orders, produced by diffraction. These dark bands or fringes can easily be seen in the microscope bordering a line deeply ruled on glass with a diamond.

If M, fig. 3, represents a transverse section of a cylinder (as a section of woody fibre or other small tube) seen in the microscope, spurious rings m_1, m_2, m_3, will under favorable circumstances be seen outside the cylinder, and also internal spurious



rings as shown in the figure. I have frequently counted as many as five such spurious rings produced by diffraction surrounding a transverse section of human hair. Internal spurious rings may be seen in transverse sections of woody fibre.

Formula (1.) also shows, by substituting successively 1, 2, 3 and 4 in place of m, that the distances of the successive fringes from the opake body will be relatively as the square roots of the odd numbers 1, 3, 5, 7, and so on; showing that the distances between the remoter fringes are less than between the lower orders. Thus if the distance of the first fringe is reckoned as unity the distance of the third fringe will be but a little more than two. The higher orders of fringes, in addition to being indistinct, will be so close together that they will not be resolved. Thus these diffraction fringes bear a close resemblance to Newton's rings.

We see by the position of the spurious lines between M and M, fig. 2, that if the real lines are very near together the spurious lines may seriously interfere with the resolvability of such series of lines as are found on Nobert's test. From formula (2.) we see that the value of y, or the distance of the first dark band from the object, represented by PC, fig. 1, is an increasing function of x, or of the depth to which the lines we are considering are cut into the glass. In this analysis we shall suppose the focus of illumination is at a little distance below the object, and that the thickness, AP, of the object is very small.

Let us take $m=1$, $\lambda=\frac{1}{5000}$ inch, and suppose C to be very large in comparison with x, we may then neglect x^2 in equation (2.), which thus becomes, $y^2=m\lambda x$.

If $x=0$ then $y=0$, or if the object has no thickness there will be no fringe when the object is seen in focus. But if such an object having absolutely no thickness is a little out of focus it will be bordered by a fringe. If $x=\lambda$ then $y=\lambda$; i. e., if $x=\frac{1}{5000}$ inch, $y=\frac{1}{5000}$ inch. If $x=4\lambda$, $y=2\lambda$. If $x=9\lambda$, $y=3\lambda$. If $x=16\lambda$, $y=4\lambda$.

If $x=\frac{1}{2}\lambda$, $y=\cdot7\lambda$. If $x=\frac{1}{3}\lambda$, $y=\cdot6\lambda$. If $x=\frac{1}{4}\lambda$, $y=\frac{1}{2}\lambda$. If $x=\frac{1}{9}\lambda$, $y=\frac{1}{3}\lambda$. If $x=\frac{1}{16}\lambda$, $y=\frac{1}{4}\lambda$, &c. From this reasoning it appears that if the real depth of a line is $x=\frac{1}{16}\lambda=\frac{1}{80000}$ inch the breadth of the line including the first fringe on either side cannot be less than $\frac{1}{16000}$ of an inch. If the lines are ruled deeper the fringes will be broader, and it becomes an important question to know how we are to overcome this obstacle to the resolvability of series of lines at the smallest distances appreciable. If instead of employing light radiating from a point directly below the object, we illuminate it by means of parallel rays at a very oblique angle, as the direct light of the sun so oblique as to illuminate only one side of the lines, the fringes on the side not illuminated would be scarcely perceptible, and the microscope may be so focussed that the visible fringes shall overlie or apparently coincide with the real lines when the lines will be easily resolved. Here theory beautifully coincides with observation, for in just those conditions lines are resolved in the microscope, which defy resolution by other methods.

Another important phenomena of diffraction remains to be noticed. Let QRST, fig. 4, be an opake object, in addition to diffraction from the points S and T, which have been noticed above, the points Q and R also act as new centres of radiation throwing light into the shadow QR*qr*. If the light proceeded only from one of the points Q or R, there would be no dark bands formed above the object, and the light would gradually fade away from the border towards the centre of the shadow. But by reason of the meeting of the rays diffracted from opposite sides into the shadow, a bright line will be seen in the centre of the shadow when the focus of the microscope is adjusted to a plane *qr* a little above the object, and if the shadow is broad enough there may be dark lines on either side of the central bright line formed by concurrence of rays from the opposite sides. A perfect microscope should have its focus confined to a mathematical plane, i. e., the focus of the central and border rays should coincide, or the object glass should be free from spherical aberration, but this result is only approximately secured in ordinary achromatic objectives. The result is that the field of vision has a certain depth, so that if a very thin object is carefully focussed in the microscope, this spurious bright

4.

line above a real opake line is often visible. This peculiarity of microscopic vision frequently makes a fine opake line appear double.

If, to avoid seeing the spurious bright line above a real opake line, and also to diminish the breadth of the fringes formed by diffraction from the lower part of the line, we bring the lower part of the object into focus we encounter another difficulty in resolving a series of lines. The light transmitted does not form a sufficient angle and the space between the lines, if they have much thickness, appears dark, as is the case with natural vision when looking into a long tunnel.

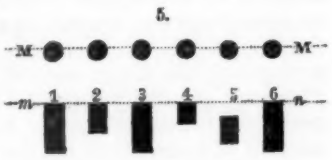
I will now bring together some practical conclusions deduced from the above discussion and more or less comfirmed by experiment.

First. If a minute object, whether a speck or a line, having an appreciable depth, is examined in the microscope, the effect of diffraction is to increase its apparent breadth. A speck appears larger than it really is, a line or thread-form object appears wider than it should be and the edge of a diatom appears black and indistinct. These facts are recognized by Hartung, "Das Mikroskop," &c., § 247, but I am not aware that any writer has given an explanation of these facts.

Secondly. A single line under favorable circumstances appears bordered with fringes or spurious lines which in examining an unknown object may often lead to erroneous views of the real structure. This error is more liable to occur where dots or cell structures are examined. Cells having but a single wall may appear enclosed with double or triple walls, and opake molecules may appear as though enveloped by a cell wall. The practiced eye will doubtless learn to detect such fallacies.

When the first band of Nobert's test, the lines of which are at the distance of $\frac{1}{111\frac{1}{2}}$ of an inch, is viewed in such a position that the lines appear intensely black, these black lines are not the real grooves cut by the diamond but the spaces between the lines occupied by dark fringes produced by diffraction, while the bright spaces are the bright lines of double intensity over the real lines, as explained above by means of fig. 4. By bringing the objective nearer to the lines the black lines disappear and light spaces take their places, while the fine cuts of the diamond appear where the bright lines were previously seen. Beside this when the intensely black lines appear, the outer lines are narrower than the others and the number is greater by one than the real lines. If this series of lines is illuminated by sunlight or by artificial light of great intensity, the colors of the spectrum, especially the blue, yellow and red, can be clearly seen in the first diffraction band on each side of the diamond

cut. In the 23d band on the Nobert's test, employed by the writer, with a moderate power irregular lines are seen, indicating that the depth of the lines is not uniform but more like the opake lines 1—6 seen in section at *m n*, fig. 5. Still further, when viewing the first band of Nobert's test, the focus can be so adjusted that each line appears like two dark lines.



In this case there is no great danger of mistaking the number of the real lines, but with lines ruled much deeper for the purpose of experiment there is great difficulty in determining the number of real lines. Every observer has doubtless noticed when examining diatoms or other delicate objects with oblique light, a fainter image overlying the real object. I have often been puzzled to tell whether these two images did not belong to opposite sides of the diatom. May not this phenomena be due to diffraction?

The sources of error here indicated may possibly help to explain the discrepancy in the number of lines seen on particular species of Diatomaceæ as reported by different observers.

Thirdly. The theory of diffraction would indicate that a series of wires or threadform objects, such as are shown in section at M M, fig. 5, offer less impediment to resolution than objects of other forms, for the reason that a cylindrical surface diffracts the light less than a sharp edge or angle. According to Hartung ("Das Mikroskop," p. 722) Amici's microscope of 94° aperture resolved a network of wires whose diameter was $\frac{1}{8\,1\,4\,8}$ m. m. $= \cdot 000064 = 3\lambda$, with spaces between the wires of $\frac{1}{3\,7\,3\,5}$ m. m. $= \cdot 000102$, while a single thread-form object could be seen with the same instrument when its diameter was only $\frac{1}{1\,1\,3\,5\,5}$ m.m. or only about one-seventh the diameter of the wire grating.

If we suppose the microscope to be so focussed as to allow the upper surface of the wire grating to be seen, and call the semi-diameter of the wire $1\frac{1}{2}\lambda$, the breadth of the first fringe on either side would be $y = 1{\cdot}2\lambda$, the apparent increase of the breadth of the wire would be $2{\cdot}4\lambda = \cdot 000048$ inch. The entire apparent breadth of the wire would become ·000112 in., leaving an apparent clear space of ·000054 in., which would appear as a bright line having a breadth of $\frac{1}{1\,8\,5\,0\,0\,0}$ inch.

Fourthly. If we examine in the microscope a crystal, so small that the breadth of the diffraction fringe bears a considerable proportion to the breadth of the crystal, the effect of diffraction is to make the crystal appear as a round speck, and its crystalline form cannot be clearly distinguished. Here theory is abundantly confirmed by experiment. How difficult then must it ever be to distinguish minute organic germs from inorganic dust!

Lastly. Diffraction presents an important practical difficulty in the microscopic investigation of common objects. Transverse sections of hairs appear in the microscope surrounded with one or more fringes or rings. In some cases I have counted five distinct rings. In other cases a single ring with a dark border is seen giving the appearance of a thick cuticle covering the hair. This ring, generally supposed to be the cuticle, varies in thickness with the length of the sections examined. On transverse sections of human hair not more than one-fourth as long as they are broad this ring diminishes in breadth until it appears as a mere film or entirely disappears. Now although I believe there is no doubt that the outer cells of the hair differ in structure from those more internal, I seriously doubt whether this ring, called the cuticle, which surrounds transverse sections of hair is what it is usually supposed to be. Again transverse sections of woody fibre appear to show a laminated structure of the cell walls, one layer within another, which is generally supposed to prove that the cellulose is deposited within the wood cells in successive layers. I frequently find at least one internal ring, and, when the wood cells are slightly separated, one external ring that are without doubt due to diffraction. Some of the other so-called laminæ I have suspected to be due to the same cause. It is very difficult to tell how much of this appearance is due to organic structure and how much depends upon diffraction, but the phenomena of diffraction set forth in this paper would seem to require that this whole subject of cell structure and growth should be carefully reëxamined.

The binocular microscope has given me much assistance in detecting fallacies produced by diffraction, but the imperfections of this instrument as at present constructed prevent its useful application to the resolution of lines finer than $\frac{1}{125000}$ of an inch.

The first five bands of Nobert's test, when seen in the binocular microscope, show that the coarser bands are cut much deeper into the glass than the finer lines. While this instrument shows the first and second bands like a series of plates set up edgewise, the lines in the bands above the fifth appear only as delicate scratches upon the surface of the glass. I hope that further improvements in the binocular microscope and the labors of other observers will give us more perfect knowledge of minute structures than we possess at present.

New Haven, Conn., April 3d, 1862.

ART. XXXIX.—*Discovery of Microscopic Organisms in the Siliceous Nodules of the Palæozoic Rocks of New York.*

AT Prof. Dana's suggestion, Dr. M. C. White, well known for his devotion to the microscope, has examined various specimens of the hornstone nodules found in the Devonian and Silurian rocks of this country, with a view to determine the presence of organisms analogous to those well known to exist in the flints of the Chalk. This research has been rewarded by the discovery of abundant organisms referable to the Desmidieæ, besides a few Diatomaceæ, numerous spicula of sponges, and also fragments of the dental apparatus of Gasteropods. Among the Desmids, there is a large variety of forms of Xanthidia supposed to be the Sporangia of Desmids, besides an occasional duplicated Desmid; also, lines of cells, some of which appear to be sparingly branched. The researches have been mostly confined to the hornstone of the Corniferous limestone; though extended also to the hornstone from the Black River limestone and that of the Sub-Carboniferous limestone of Illinois, both of which contain some organisms.

The hornstone nodules from the Black River limestone (as well as the Corniferous) have been since examined also by Mr. F. H. Bradley with similar results.

These observations will be regarded with much interest by geologists as well as by microscopists. They carry back to a very early epoch forms of life which have hitherto been looked upon as belonging only to a much more recent era in the life of our planet.

The analogy of these hornstone nodules to the flints of the Chalk is obvious; and the discoveries here announced may be regarded as establishing their similarity in origin. The organisms figured so closely resemble those of the flint that they might be taken for them; it is difficult in all cases to make out a difference of species.

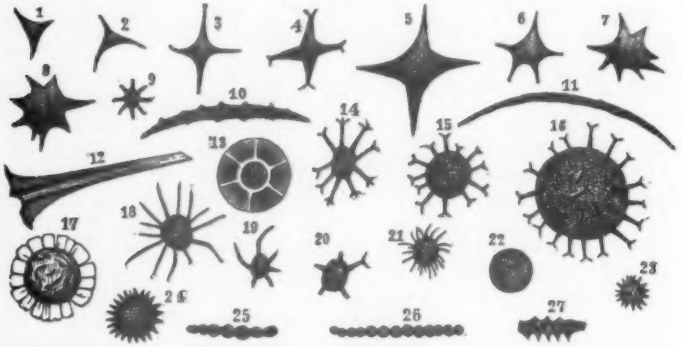
The extreme abundance of the hornstone nodules in our palæozoic limestones will render it easy to multiply observations in this new field of research, which presents an interesting addition to the labors of the microscopist. It will be remembered by those who undertake such examinations that the use of turpentine renders the chips of chert almost as transparent as glass.

We add a note from Dr. White with figures of some of the more frequently recurring forms hitherto observed by him.—*Eds.*

TO THE EDITORS:

Having recently been engaged in examining the microscopic structure of hornstone from Palæozoic rocks, I send you the accompanying sketches of organic forms which I have discovered. They consist of spicules and gemmules of sponge and fragments of sponges, Desmidieæ, several species of Xanthidia, and disks which probably are to be considered as Diatoms. Horn-

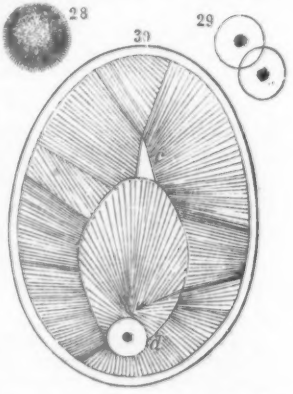
stone from the Corniferous limestone of central and western New York contains the greatest variety of these organic forms. A few specimens have been found in hornstone of the Black River Limestone from Watertown, N. Y.



Figures 10, 11 and 12 were drawn with a magnifying power of 70 diameters. Fig. 9 with a power of 400 diameters, and all the other figures with a power of 225 diameters. Figures 1 to 9, and 14 to 22, are various species of Xanthidia found in hornstone from the Corniferous limestone (Lower Devonian) of central and western New York. Figures 10, 11 and 12 are spicules of sponge from the same localities. Fig. 13 is a Diatom, on which the radial lines were faintly seen. Figures 23 and 24 are gemmules of sponge found in the hornstone of central New York. Figures 25 and 26 represent Desmidieæ, which are very abundant in the hornstone from Corniferous limestone of central and western New York. Fig. 27 is supposed to be part of a tooth of a Gasteropod.

Some of the specimens also contain spherical and ellipsoidal bodies 6-1000th to 7-1000th of an inch in diameter, the true nature of which has not been determined.

Figs. 28, 29 and 30 represent structures found in hornstone from the Black River limestone from Watertown, N. Y., magnified 225 diameters: 28 is a Xanthidium covered with very minute spines. 29 represents two Diatoms: 30 is a section of an egg-shaped body, $\frac{1}{100}$ inch in diameter, enclosed in a distinct shell, the ellipsoidal character of which was clearly shown in specimens from the Corniferous limestone, the shell being filled with very nearly transparent quartz. The specimen shown in the figure, found in the hornstone from the Black River limestone, is filled with a crystalline substance of a silky appearance, very nearly transparent. Near the larger end is a disk, *d*, which is probably to be regarded as a Diatom: *c* is probably a crystal. The thickness of the ellipsoidal shell is about $\frac{1}{2000}$ of an inch.



These investigations were undertaken at the suggestion of Prof. Dana, who furnished the specimens of hornstone, the examination of which has enabled me to make these most interesting discoveries.

Yours, &c.

New Haven, Conn., March 22, 1862.

M. C. White.

Art. XL.—*Colorado River of the West.**

For a number of years prior to the commencement of the present war in which our country is so unhappily involved, an annual appropriation of from 50,000 to 100,000 dollars has been made by Congress, for explorations and surveys in unknown regions west of the Mississippi, to be expended under the direction of the Topographical Bureau. Expeditions were therefore sent out to various parts of the West, with specific instructions as to the unexplored district to be examined, and a party organized, composed of topographers, meteorological observers, geologists, artists, &c., and placed under the command of an officer of the U. S. Topographical Corps. With an appropriation of 25,000 dollars, Lieut. Ives was ordered in the spring of 1857, to examine the unexplored region bordering upon the great Colorado of the West and to ascertain the navigability of that river. How well Lieut. I. and his assistants performed the duty entrusted to them the volume before us bears ample testimony. We regard it as one of the most important and most finished reports yet published by the U. S. government in regard to the West, and so far as the labors of the authors are concerned, it is in the highest degree creditable to them. While thus examining the Report before us with real pleasure we cannot but feel the profoundest regret that so able and accomplished an officer as Lieut. Ives, a native of New York City, but reared in New England, should at this time be found fighting in the ranks of the enemies of our country, lost to science and the world, at war not more with the government which has educated and advanced him than with his own convictions of right and duty.

We quote that portion of the introduction which relates to the history of Colorado explorations and the organization of the expedition.

"The Colorado of the West is the largest stream, with one exception, that flows from our Territory into the Pacific Ocean. It has its sources in the southern portions of Nebraska and Oregon, and in its course to the Gulf of California drains two-thirds of the Territory of New Mexico, and large portions of Utah and California, an area of more than 300,000 square miles.

Very little has been known concerning this river. Two streams, Green and Grand rivers, which flow through Utah in a southerly direction, have been supposed to unite somewhere near the southern boundary of

* Report upon the Colorado River of the West; explored in 1857 and 1858 by Lieutenant Joseph C. Ives, Corps of Topographical Engineers, under the direction of the office of Explorations and Surveys; A. A. Humphreys, Captain Topographical Engineers in charge. By order of Secretary of War. 364 pages 4to of text, with numerous engravings, 3 plates of fossils, 4 maps, two topographical and two geological.

that Territory and form the Colorado, but the point of junction has never been visited nor determined. For hundreds of miles below this point the stream has not been seen, till recently, by white men, excepting at one spot, and few Indians, for centuries past, have been near its banks. Notwithstanding this, some portions of the river were among the earliest parts of America to be explored. In less than fifty years after the landing of Columbus, Spanish missionaries and soldiers were travelling upon the Colorado, following its course for a long way from the mouth, and even attaining one of the most distant and inaccessible points of its upper waters. More information was gained concerning it at that time than was acquired during the three subsequent centuries.

In the year 1540 the viceroy of New Spain, interested in the accounts derived from a Franciscan monk of the latter's travels in the Territory now called New Mexico, sent an exploring expedition into that region under the command of Vasquez de Coronado. A detachment of twenty-five men, led by one Diaz, left Coronado's party and travelled westward. They discovered the Colorado and followed it to its mouth. Their description of the river and of the tribes they met upon it is not at all inapplicable to the condition of things at the present day, though the statements concerning the prodigious size of one community of Indians that they encountered are a little exaggerated. The Mojaves, to whom, doubtless, they refer, are perhaps as fine a race of men, physically, as can anywhere be found, but they do not quite come up, in stature and strength, to the descriptions of the Spaniards.

About the same time Captain Fernando Alarçon, by order of the viceroy, sailed up the Gulf of California and ascended the Colorado in boats for a long distance. The account of what he saw agrees with that of his cotemporary explorer.

Another of Coronado's captains, named Cardinas, with a party of twelve men, reached the pueblos of Moquis, and repaired from them, with Indian guides, to a portion of the Colorado, far distant from that seen by the others. The history states that after twenty days' march, over a desert, they arrived at a river, the banks of which were so high that they seemed to be three or four leagues in the air. The most active of the party attempted to descend, but came back in the evening, saying that they had met difficulties which prevented them from reaching the bottom; that they had accomplished one-third of the descent, and from that point the river looked very large. They averred that some rocks, which appeared from above to be the height of a man, were higher than the tower of the cathedral of Seville. This was the first description of the famous Big Cañon of the Colorado.

Several times, during the succeeding two centuries, the lower part of the river was visited by Catholic priests. In 1744 a Jesuit missionary, named Jacob Sedelmayer, went thither, following the course of the Gila, and travelled extensively in both New Mexico and Sonora, and about thirty years afterwards the Jesuits established missions among the Yuma Indians, who live at the junction of the Gila and Colorado. The priests were subsequently massacred by the fierce tribe among whom they had located themselves.

In 1776 another Catholic missionary, Father Escalante, travelled from

Santa Fé to Utah, and having explored the region south of the Great Salt Lake, pursued a southwesterly course, towards the sources of the Virgin, and then crossed to the Colorado, which he reached at a point that appears to have been almost identical with that attained, from the opposite direction, by Cardinas, more than two centuries before.

From this time the river was scarcely approached, excepting by an occasional trapper, or some overland party crossing the lower portion, *en route* to California. A considerable part of the emigration, induced by the gold discoveries in that region, passed through New Mexico, by way of the Gila, and the travellers were subjected to molestation from the Yumas. In 1850 a detachment of troops was sent to the mouth of the Gila to keep these Indians under control, and not long afterwards a military post, called Fort Yuma, was regularly established.

The difficulty of furnishing supplies to the garrison, across the desert, was such that, in the winter of 1850 and 1851, General Smith, commanding the Pacific division, sent a schooner from San Francisco to the head of the Gulf of California, and directed Lieutenant Derby, topographical engineers, to make a reconnaissance, with a view of establishing a route of supply to Fort Yuma, *via* the Gulf and the Colorado. The result of the reconnaissance was successful, and the route was at once put in operation. The freight, carried in sailing vessels to the mouth of the river, was transported to the fort—the distance to which, by the river, is one hundred and fifty miles—at first in lighters, and afterwards in steamboats.*

In 1851, Captain Sitgreaves, U. S. topographical engineers, with a party of fifty individuals, made an exploration from Zuni westward. He struck the Colorado at a point about 160 miles above Fort Yuma, and followed the east side of the river, keeping as near to the bank as possible, to the fort. He encountered the Mojaves, and found their appearance and customs generally to agree with the descriptions of the early explorers. The descent was accompanied with hardship and danger. Both the Mojaves and Yumas were hostile, and the difficulty of travelling near the river was extreme, owing to the chains of rugged and precipitous mountains that crossed the valley. The summer heats had parched and withered the face of the country; the stream was low, and what was seen of it did not create a favorable opinion regarding its navigability.

In the spring of 1854 Lieutenant Whipple, topographical engineers, in command of an expedition for the exploration and survey of a railroad route near the 35th parallel, reached the Colorado, at the mouth of Bill Williams's Fork, and ascended the river about fifty miles, leaving it at a point not far below where Captain Sitgreaves had first touched it. The expedition was composed of nearly a hundred persons, including the escort. The Mojaves were friendly, furnishing provisions to the party, whose supply was nearly exhausted, and sending guides to conduct them by the best route across the desert westward. The river was probably higher than when seen by Captain Sitgreaves, and it was the opinion of Lieutenant Whipple that it would be navigable for steamers of light draught. The course of the Colorado northward could be followed with the eye for only a short distance, on account of mountain spurs that crossed the valley

* A fuller account of the opening of this route is given in a subsequent chapter.

and intercepted the view. A high distant range, through which the river apparently broke, was supposed to be at the mouth of the 'Big Cañon,' which the Spaniards, in 1540, had visited at a place far above.

The marvellous story of Cardinas, that had formed for so long a time the only record concerning this rather mythical locality, was rather magnified than detracted from by the accounts of one or two trappers, who professed to have seen the cañon, and propagated among their prairie companions incredible accounts of the stupendous character of the formation. It therefore became a matter of interest to have this region explored, and to lay down the positions of the Colorado and its tributaries along the unknown belt of country north of the 35th parallel. The establishment of new military posts in New Mexico and Utah made it also desirable to ascertain how far the river was navigable, and whether it might not prove an avenue for the economical transportation of supplies to the newly occupied stations.

There was no appropriation that would enable the War Department to accomplish this service until the summer of 1857, when the present Secretary of War, having the disposition of a certain amount to be expended in field examinations, set apart a portion of it for the exploration of the Colorado, and directed me to organize an expedition for that object.

To ascertain how far the river was navigable for steamboats being the point of primary importance, it was necessary first to make provision for this portion of the work. The company employed in carrying freight from the head of the Gulf to Fort Yuma were unable to spare a boat for the use of the expedition, excepting for a compensation beyond the limits of the appropriation. A boat of suitable construction had, therefore, to be built on the Atlantic coast and transported to San Francisco, and thence to the mouth of the river. In order that the survey should be made at the worst and lowest stage of the water, I had been directed to commence operations at the mouth of the Colorado on the 1st of December. This left little time for preparation, considering that it was necessary to build a steamer and carry the parts to so great a distance.

In the latter part of June I ordered of Reaney, Neafie & Co., of Philadelphia, an iron steamer, fifty feet long, to be built in sections, and the parts to be so arranged that they could be transported by railroad, as the shortness of time required that it should be sent to California, *via* the Isthmus of Panama. About the middle of August the boat was finished, tried upon the Delaware, and found satisfactory, subject to a few alterations only. It was then taken apart, sent to New York, and shipped on board of the California steamer which sailed on the 20th of August for Aspinwall. Mr. A. J. Carroll, of Philadelphia, who had engaged to accompany the expedition as steamboat engineer, went out in charge of the boat.

The transportation of the steamer was, to the parties concerned, a source of more trouble than profit, but the kind offices of the agents of the Panama Railroad Company, and of the captains of the steamships on both the Atlantic and Pacific coasts, united to the careful supervision of Mr. Carroll, enabled the awkward mass of freight to reach San Francisco in safety by the first of October.

Dr. J. S. Newberry was appointed physician to the expedition, and

also to take charge of the natural history department. This gentleman had previously made extensive geological surveys in California and Oregon while attached to the party of Lieutenant Williamson, topographical engineers, in charge of the Pacific railroad surveys in those regions.

Mr. F. W. Egloffstein, who had been attached to Frémont's expedition of 1853, and had subsequently been employed with the party that explored the Pacific railroad route near the 41st parallel, was appointed topographer. Messrs. P. H. Taylor and C. K. Booker were the astronomical and meteorological assistants. A gentleman belonging to the household of Baron Von Humboldt, Mr. Mollhausen, who had been a member of the exploring party of Prince Paul of Wirtemburg, and also of Lieutenant Whipple's expedition, received from the Secretary of War the appointment of artist and collector in natural history."

The Journal of Lieut. Ives is full of interesting descriptions of incidents of the trip, accounts of numerous tribes of Indians, scarcely known prior to his visit, as the Moquis, Mojaves, &c. An important hydrographic report of 14 pages is also appended. We have room only for the vivid description of that remarkable passage in nature, the Black Cañon, given on pages 85, 86, and 87.

"*Camp* 59, *head of Black Cañon, March* 10.—The skiff having been put in tolerable order, a bucket full of corn and beans, three pairs of blankets, a compass, and a sextant, and a chronometer were stowed away in it, and a little before sunrise the captain, mate, and myself commenced the exploration of the cañon. My companions each pulled a pair of sculls, and with considerable vigor; but as the current has a flow of three miles an hour we could not make rapid progress. We had proceeded a quarter of a mile, and had just rounded the first bend, when one of the sculls snapped, reducing by half our motive power. There was, fortunately, a current of air drawing in the right direction through the narrow gorge, and, with the odd scull and a blanket, an apology for a sail was rigged, which, at intervals, rendered great assistance.

In a few minutes, having passed what may be called the outworks of the range, we fairly entered its gigantic precincts, and commenced to thread the mazes of a cañon, far exceeding in vastness any that had been yet traversed. The walls were perpendicular, and more than double the height of those in the Mojave mountains, rising, in many places, sheer from the water, for over a thousand feet. The naked rocks presented, in lieu of the brilliant tints that had illuminated the sides of the lower passes, a uniform sombre hue, that added much to the solemn and impressive sublimity of the place. The river was narrow and devious, and each turn disclosed new combinations of colossal and fantastic forms, dimly seen in the dizzy heights overhead, or through the sunless depths of the vista beyond. With every mile the view became more picturesque and imposing, exhibiting the same romantic effects and varied transformations that were displayed in the Mojave cañon, but on an enlarged and grander scale.

Rapids were of frequent occurrence, and at every one we were obliged to get out of the skiff, and haul it over. Eight miles from the mouth of the cañon, a loud sullen roaring betokened that something unusual was

ahead, and a rapid appeared which was undoubtedly the same that had been described by Ireteba. Masses of rock filled up the sides of the channel. In the centre, at the foot of the rapid, and rising four or five feet above the surface of the water, was a pyramidal rock, against which the billows dashed as they plunged down from above, and glanced upwards, like a water spout.

The torrent was swifter than at any place below, but a steamboat, entirely emptied of its cargo, which could be deposited upon the rocks alongside of the rapid, could, if provided with long and stout lines, be hauled up. During a higher stage of the river the difficulty of the place would be much diminished. With our nearly worn out ropes it would be very hazardous to attempt the ascent.

Several rapids followed at short distances, all of which would be troublesome to pass at the present depth of water. The constant getting out of the boat, and the labor of dragging it through these difficult places, made our progress for some miles exceedingly tedious and fatiguing. As sunset was approaching we came to a nook in the side of the cañon, four miles above the Roaring rapid, where a patch of gravel and a few pieces of drift wood, lodged upon the rocks, offered a tolerable camping place, and we hauled the skiff upon the shingle, and stopped for the night. There was no need of keeping a watch, with two grim lines of sentinels, a thousand feet high, guarding the camp. Even though we could have been seen from the verge of the cliff above, our position was totally inaccessible.

Darkness supervened with surprising suddenness. Pall after pall of shade fell, as it were in clouds, upon the deep recesses about us. The line of light, through the opening above, at last became blurred and indistinct, and, save the dull red glare of the camp-fire, all was enveloped in a murky gloom. Soon the narrow belt again brightened, as the rays of the moon reached the summits of the mountains. Gazing far upward upon the edges of the overhanging walls we witnessed the gradual illumination. A few isolated turrets and pinnacles first appeared in strong relief upon the blue band of the heavens. As the silvery light descended, and fell upon the opposite crest of the abyss, strange and uncouth shapes seemed to start out, all sparkling and blinking in the light, and to be peering over at us as we lay watching them from the bottom of the profound chasm. The contrast between the vivid glow above, and the black obscurity beneath, formed one of the most striking points in the singular picture. Of the subsequent appearance of things, when the moon rose higher, I do not think any of our weary party took particular notice.

This morning, as soon as the light permitted, we were again upon the way. The ascent of the river was attended with as much labor as it had been the day before; for though none of the rapids were of so violent a character, they were of constant occurrence. The wind still held to the south, and the blanket sail was again set to great advantage.

The cañon continued increasing in size and magnificence. No description can convey an idea of the varied and majestic grandeur of this peerless water-way. Wherever the river makes a turn the entire panorama changes, and one startling novelty after another appears and disappears with bewildering rapidity. Stately façades, august cathedrals, amphitheatres, rotundas, castellated walls, and rows of time-stained ruins, sur-

mounted by every form of tower, minaret, dome, and spire, have been moulded from the cyclopean masses of rock that form the mighty defile. The solitude, the stillness, the subdued light, and the vastness of every surrounding object, produce an impression of awe that ultimately becomes almost painful. As hour after hour passed we began to look anxiously ahead for some sign of an outlet from the range, but the declining day brought only fresh piles of mountains, higher, apparently, than any before seen. We had made up our minds to pass another night in the cañon, and were searching for a spot large enough to serve as a resting place, when we came into a narrow passage, between two mammoth peaks, that seemed to be nodding to each other across the stream, and unexpectedly found, at the upper end, the termination of the Black cañon.

Low hills of gravel intercepted the view, and prevented us from seeing far into the unknown region beyond. A mile above the cañon the river swept the base of a high hill, with salient angles, like the bastions of a fort. At the base was a little ravine, which offered a camping place that would be sheltered from observation, and we drew the skiff out of the water, determining not to proceed any further until to-morrow. Leaving the mate to take charge of the boat, the captain and myself ascended the hill, which is over a thousand feet high. A scene of barren and desolate confusion was spread before us. We seemed to have reached the focus or culminating point of the volcanic disturbances that have left their traces over the whole region south. In almost every direction were hills and mountains heaped together without any apparent system or order. A small open area intervened between camp and a range to the north, and we could trace the course of the river as it wound towards the east, forming the Great Bend. In the direction of the Mormon road to Utah, which is but twenty miles distant, the country looked less broken, and it was evident that there would be no difficulty in opening a wagon communication between the road and the river. We tried to discover the valley of the Virgin, but could see no indication of any stream coming in from the northwest. The view in that direction was partially obstructed by another summit of Fortification rock.

Not a trace of vegetation could be discovered, but the glaring monotony of the rocks was somewhat relieved by grotesque and fanciful varieties of coloring. The great towers that formed the northern gateway of the cañon were striped with crimson and yellow bands; the gravel bluffs bordering the river exhibited brilliant alternations of the same hues, and not far to the east, mingled with the gray summits, were two or three hills, altogether of a blood-red color, that imparted a purely ghastly air to the scene.

The approach of darkness stopped further observations, and we descended to camp, having first taken a good look in every direction, for the smoke of Indian camp-fires, but without discovering any. In making the sixteen miles from last night's bivouac, we have had to labor hard for thirteen hours, stemming the strong current, and crossing the numerous rapids, and being thoroughly exhausted, depend for security to-night more upon our concealed position than upon any vigilance that is likely to be exhibited."

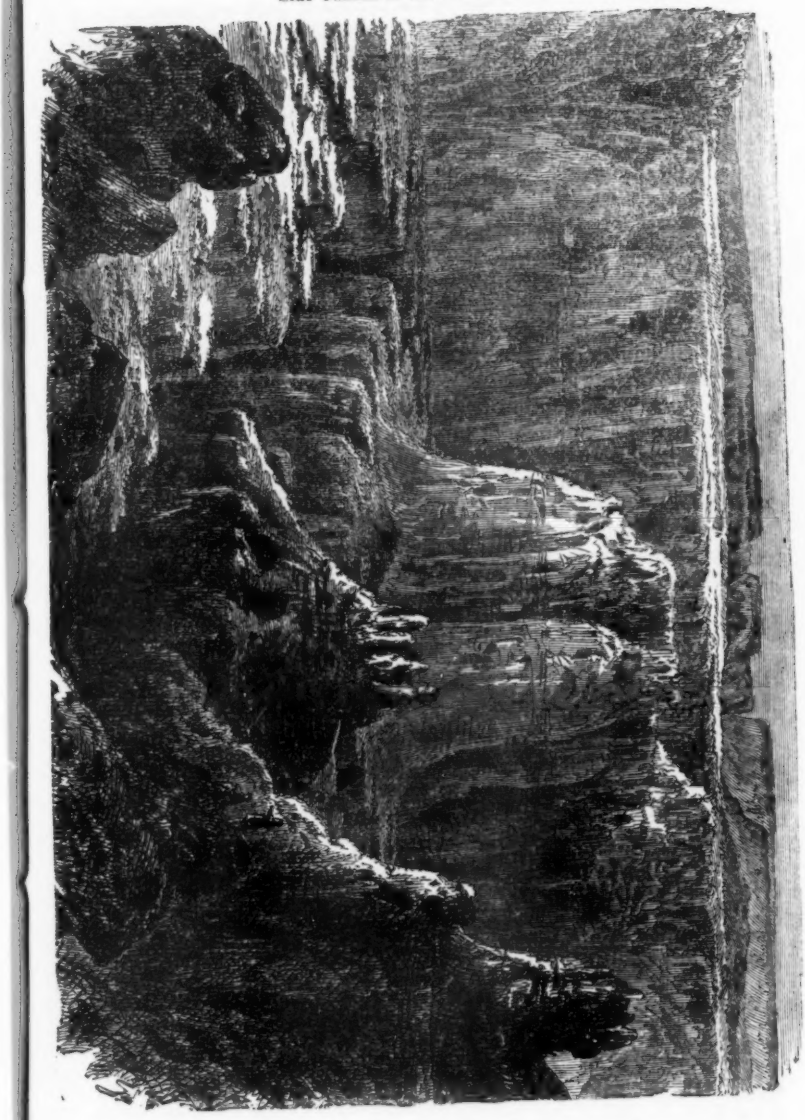
The greater portion of Lieut. Ives' report is in the form of a Journal, noting the current events of each day, in a style clear and attractive. His descriptions of the numerous cañons along the Colorado are exceedingly graphic and beautiful. On page 101 we have the following description of the side cañons of the Colorado, which are well depicted in the annexed engraving:

"A few of the Hualpais paid us a visit, but their intelligence is of so low an order that it is impossible to glean information from them, and their filthiness makes them ojectionable. Our new guides seemed to think we should have difficulty in ascending to the portion of the plateau which they traverse on the way to higher points upon the river. The route they ordinarily pursue follows the cañon of Diamond creek, but this they pronounced impracticable for mules, and said that we must retrace our course for several miles in order to strike a more circuitous, but easier trail, that ascended one of the branch cañons.

Following their advice and guidance, yesterday morning we toiled up the rough road by which we had come, for six miles, when they struck off into a side ravine that led towards the southeast. Half a mile from the mouth, the Hualpais told Ireteba that our camping place was just ahead, and scrambling over the summit of a hill, in a minute were both out of sight. For a mile we kept on, every few moments coming to a fork, where the selection of the right road was left to chance. There was a network of cañons, and the probabilities were that nine out of ten would lead to an impassable precipice. The ascent became so rough that it was already almost impracticable for the mules, and at last the Mojaves stopped, declaring that they had lost their way, and had no idea how to find the camping place or the water, and that the Hualpais were a very bad set. This opinion no one was inclined just then to dispute. I however asked one of the Indians to go back and endeavor to find the deserters or some other member of their tribe. We waited impatiently for half an hour, and then the order was given to countermarch, for I intended to search for the route by which we had come; but before going far, the little Hualpais came back. He seemed amused that we should not have been able to find the water, and again took his place at the head of the column. He conducted us for two miles through a difficult and intricate maze of ravines, and then climbed a side hill, and in a most unexpected place pointed out a little spring. There was a sufficiency of water, and tolerable grass near by. The second Hualpais came back during the evening, and seemed also to be astonished that we should have had trouble in finding what to him was so familiar. They both professed a determination to accompany the train, and Ireteba told me that it was time for himself and companions to return."

In securing the services of Dr. Newberry as Geologist and Naturalist of the expedition, the Department was fortunate—his well known ability in these branches of science, as well as his previous experience in connection with other expeditions in the far west, peculiarly fitting him for the task. His report is ably drawn up and contains lucid descriptions of the geological and physical features of the country along the line of exploration.

Side Cañons of the Colorado.



The numerous great gorges and profound cañons cut by the erosive action of water, through thousands of feet of strata, in a district where the rocks have, for the most part, suffered little or no disturbance since their deposition, afforded him a fine opportunity to study its geological structure. Probably in no other part of the world can so great a thickness of strata be seen and examined inch by inch in one continued section as here. These tremendous chasms cleaving the beds, as they do almost vertically sometimes to the astonishing depth of from three to six thousand feet, reveal every bed and layer of rock from top to base, as clearly and distinctly as they can be seen in the artificial excavations along our rail-roads.

In the great Cañon of the Colorado, on a high mesa, west of the Little Colorado, Dr. N. saw at a single exposure in regular succession the following formations:

1st. Upper Carboniferous limestone surmounting beds of cross-stratified sandstones, and red calcareous sandstones with gypsum, altogether, 1200 feet.

2d. Lower Carboniferous limestone, 1000 feet.

3d. A great thickness of limestone shales, and grits, apparently of Devonian age, resting upon heavy deposits of limestone, mud rocks, and sandstones, apparently of Silurian age, with a sandstone at the base, probably representing the Potsdam sandstone of New York: the whole not less than 2,300 feet.

Beneath all these stratified rocks the gorge is excavated so as to expose 1000 feet of granite.

Of these rocks Dr. Newberry remarks that, "the Silurian and Devonian strata are entirely conformable among themselves, and with the Carboniferous rocks. They lie nearly horizontal upon the granite, forming a series of sandstones, limestones, and shales, about 2000 feet in thickness. The Carboniferous series consists of over 2000 feet of limestones and gypsum, apparently all massive, and often highly fossiliferous. The upper members of the latter series form the surface of the mesas of the Little Colorada, upon which the volcanic group of the San Francisco mountains rest as a base."

At other localities Dr. N. had opportunities to examine the succeeding formations above those just alluded to. One of these, at the crossing of the Little Colorado, where one side of the valley is formed by a third mesa wall, which with the slope at its base rises to an elevation of at least one thousand feet in height above the stream.

"This mesa," he says, "is composed of deep-red sandstones, shales, and conglomerates, resting conformably on the Upper Carboniferous limestone, over which is a series of variegated marls, with bands of magnesian limestone. The latter series forms the surface of the mesa for many miles towards the northeast, and has an aggregate thickness of perhaps 1,500 feet.

The variegated marls and the underlying red sandstones are all regarded as Triassic by Mr. Marcou; but the marls exhibit a remarkable lithological identity from top to bottom, and the upper portion contain plants of Jurassic affinities. Without more fossils from these formations it seems to me, at least doubtful whether we can draw the lines of classification as sharply as he has done; and it would even be a little surprising if there should ever be found good palæontological evidence for the identification of all the European subdivisions of the Permian, Triassic, Jurassic, and Chalk, of which he claims to have demonstrated the existence in this vicinity.

Upon the mesa of the variegated marls at the Moquis village rises still another, to the height of 800 or 900 feet, composed of coarse yellow sandstones, green shales, and beds of lignite—a group of strata which has been called Jurassic, but which contain impressions of dicotyledonous leaves, with *Ammonites*, *Gryphæa*, and *Inoceramus* of Cretaceous species. These fossils leave no room for doubt in reference to the age of the strata which contain them, but prove them to be Lower Cretaceous."

The enormous thickness of strata is at places surmounted by another series of great thickness. This series is thus alluded to by Dr. N.

"Going north from the Moquis villages, on the Lower Cretaceous mesa, our progress was arrested by a want of water; the surface being everywhere cut by deep cañons, by which it is drained to excess; every rain drop which falls finding its way immediately into the bottom of these ravines, where it is hurried off to the far deeper cañons of the Colorado and its larger tributaries. Before we turned back, however, we had approached nearly to the base of a wall rising abruptly from the mesa in which we stood to the height of more than 1,000 feet. This wall was as white as chalk, and reflected the sunlight like a bank of snow. It is evidently the edge of another and higher plateau, and apparently reaches to the Great Colorado, where it caps the 'high mesa,' forming part of the stupendous mural faces, presented toward the south and west, which were distinctly visible when we had receded from them to the distance of a hundred miles.

What is the character of this upper mesa I had no means of determining at this time, and even now there may be some question about it; but I have scarcely a doubt that it is composed of the Upper Cretaceous strata, the equivalents of the 'white chalk' of Europe."

In regard to the causes which have produced the remarkable topographical features of this interesting region, Dr. Newberry shows that it is not due, as would probably be supposed by one not accustomed to the study of such phenomena, to volcanic or eruptive agencies, but solely to the erosive action of running water. Thus he continues:

"The sketch which has been given of the table-lands of the upper Colorado, though brief, will perhaps suffice to convey an idea of the generalities of their structure and relations. But before returning to the details of the local geology of our route, I ought perhaps to refer briefly to two questions of general import, which would naturally suggest them-

selves to any geologist who should traverse the table-lands west of the Rocky mountains, or should receive an accurate description of them from others.

The first of these questions is: To what cause is due the peculiar topographical features of the surface of the table lands—where the different formations succeed each other in a series of steps, which generally present abrupt and wall-like edges—the more recent strata occupying the highest portion of the plateau? The other has reference to the place and extent of the dry land, of which the erosion furnished the sediments now composing the table-lands.

The first of these questions belongs appropriately to the subject of surface geology, and will be referred to again. I may say here, however, that, like the great cañons of the Colorado, the broad valleys bounded by high and perpendicular walls *belong to a vast system of erosion, and are wholly due to the action of water.* Probably nowhere in the world has the action of this agent produced results so surprising, both as regards their magnitude and their peculiar character. It is not at all strange that a cause, which has given to what was once an immense plain, underlaid by thousands of feet of sedimentary rocks, conformable throughout, a topographical character more complicated than that of any mountain chain; which has made much of it absolutely impassable to man, or any animal but the winged bird, should be regarded as something out of the common course of nature. Hence the first and most plausible explanation of the striking surface features of this region will be to refer them to that embodiment of resistless power—the sword that cuts so many geological knots—volcanic force. The Great Cañon of the Colorado would be considered a vast fissure or rent in the earth's crust, and the abrupt termination of the steps of the table-lands as marking lines of displacement. This theory though so plausible, and so entirely adequate to explain all the striking phenomena, lacks a single requisite to acceptance, and that is *truth.*

Aside from the slight local disturbance of the sedimentary rocks about the San Francisco mountain, from the spur of the Rocky mountains, near Fort Defiance, to those of the Cerbat and Aztec mountains on the west, the strata of the table-lands are as entirely unbroken as when first deposited. Having this question constantly in mind, and examining with all possible care the structure of the great cañons which we entered, I everywhere found evidence of the exclusive action of water in their formation. The opposite sides of the deepest chasm showed perfect correspondence of stratification, conforming to the general dip, and nowhere displacement; and this bottom rock, so often dry and bare, was perhaps deeply eroded, but continuous from side to side, a portion of the yet undivided series lying below."

In an attempt to restore the physical geography of this region during the Palæozoic age, Dr. Newberry remarks:

"The question of the origin of the sediments composing the stratified rocks of the table-lands of the Colorado can scarcely be intelligently discussed till we know more than we now do of the geology of a large area lying north of the Colorado, and of the broad and compound belt of

mountains, which we have covered by a single name, (Rocky mountains,) but which, when carefully studied, will probably not be found to form a geological unity.

This much, however, we can fairly infer from observations already made on the geological structure of the far west, viz: That the outlines of the western part of the North American continent were approximately marked out from the earliest Palæozoic times; not simply by areas of shallower water in an almost boundless ocean, but by groups of islands and broad continental surfaces of dry land.

Since the erosion of rocks is always subaerial, or at least never takes place more than forty feet below the ocean surface, it follows that to form the stratified rocks of only that portion of the great central plateau which borders the Colorado, an island 300 miles in diameter, and at least 6,000 feet high, or, what is more probable, a continent of six times that area and 1,000 feet high, was worn down by the action of waves and rains, and in the form of sediments, sand, gravel, clay or lime, deposited on the sea bottom.

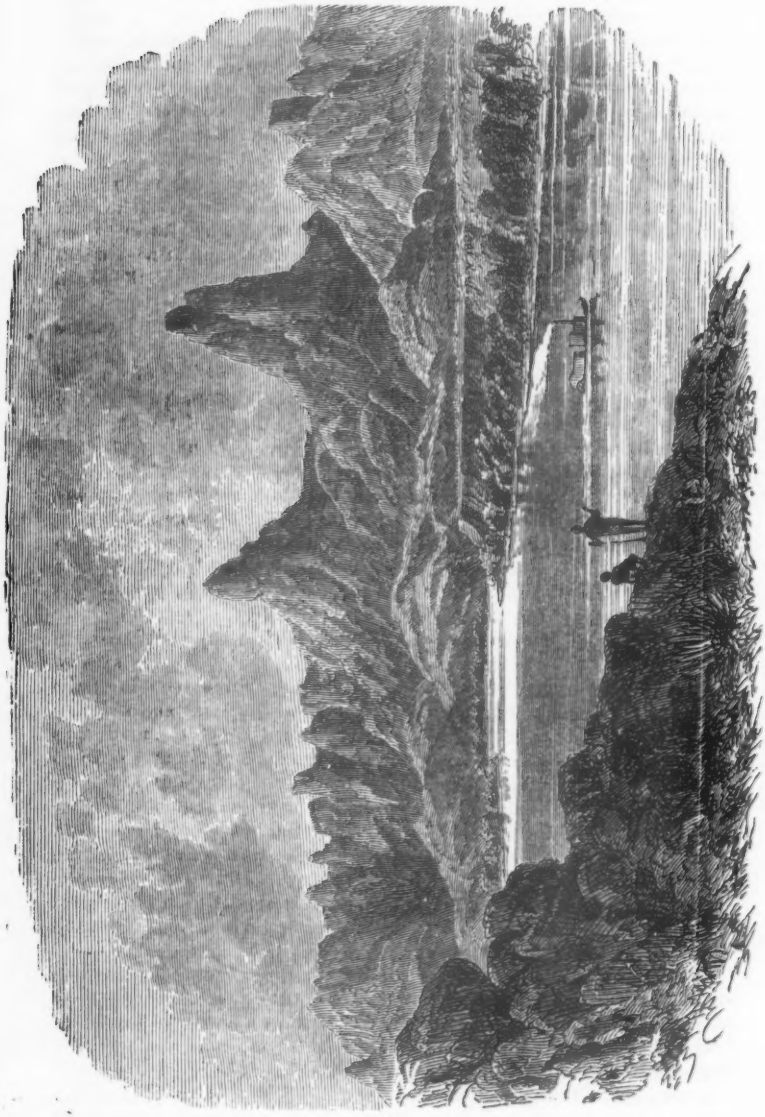
When we reflect that, with the exception of narrow wedges of erupted material in the mountains, an area having, on the 36th parallel, the breadth of the entire distance between the great bend of the Colorado and the Mississippi, (1,200 miles,) and a great, though yet unmeasured extension north and south is occupied by several thousand feet of Palæozoic and Secondary strata, we must conclude that these sediments have not been derived from the erosion of emerged surfaces east of the Mississippi, but here formed by the incessant action of the Pacific waves on shores that perhaps for hundreds of miles succumbed to their power and by broad and rapid rivers which flowed from the mountains and through the fertile valleys of a primeval Atlantis.

I have already alluded to the absence of the Silurian and Devonian rocks from the sections on the flanks of the Rocky mountain axes in New Mexico, while they occur in great thickness in the sections of the cañon of the Colorado, and that they were deposited around, and abutting in horizontal stratification against, the granitic spurs of the mountains bounding the table-lands on the west; and further, that the axes of these mountains are on the east side flanked by Carboniferous strata resting on the granite; the Silurian and Devonian rocks being absent. These facts show that the older Palæozoic strata were deposited in a trough or basin bounded on the east and west by granitic mountains which rose above the ocean's surface.

The Potsdam (?) sandstone which is largely developed in the Great Cañon is a coarse silicious rock that must have been derived from the erosion of land at no great distance.

It is true that the Silurian, Devonian, and Lower Carboniferous limestones are, where I examined them, nearly destitute of fossils, and seem to be deep-sea deposits, but shore lines would doubtless, by proper search, be found, where fossils are abundant, within a few miles of the localities where these strata are exposed on our route.

It would seem that in that vicinity (mouth of Diamond river) the water shoaled by the deposition of the sediments forming the older rocks, as the overlying Carboniferous strata abound in fossils, and one of the members



of that series, a sandstone, everywhere affords striking evidence of current action in its cross stratification.

In harmony with this fact is the occurrence of true coal measures with beds of coal, indicating emerged land at that epoch, north of the Colorado, at no great distance from this locality.

Hence the theory generally received that the formation of the continent began in a nucleus about Lake Superior, and that the places of the Rocky and California mountains were, until the Tertiary period, occupied by an open sea is proved untenable."

The engraving on the opposite page showing Chimney Peak range is thus described:

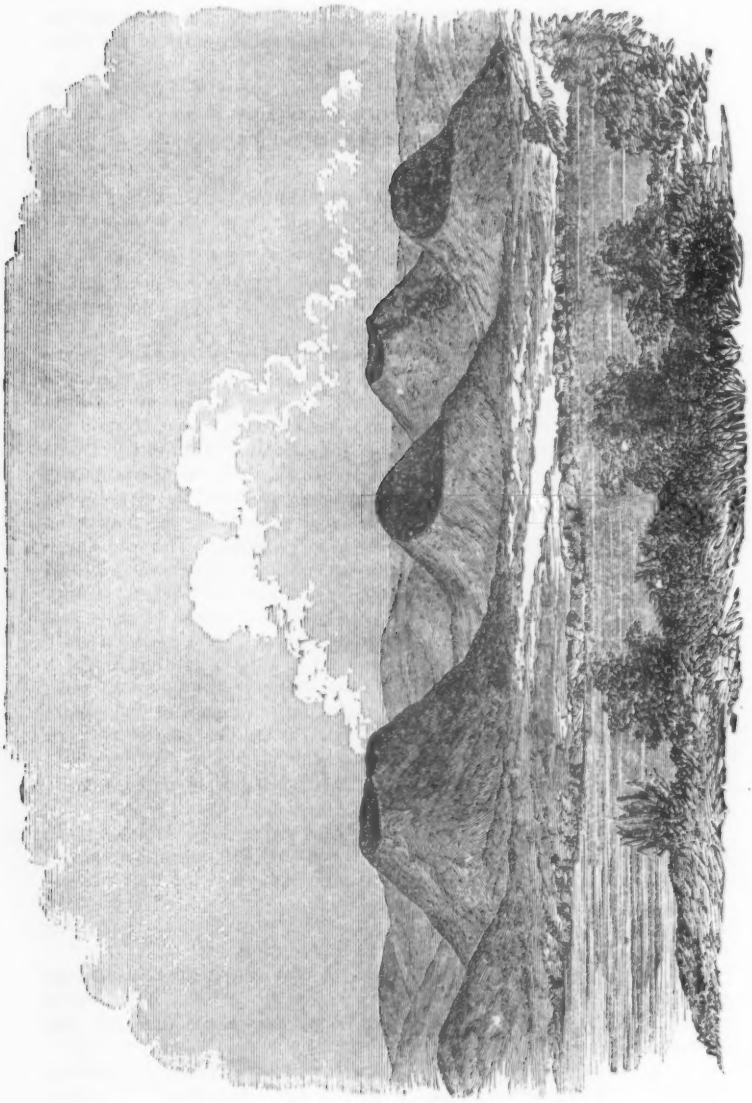
"Above the mica slate hills, red, white, green, pink, and blue tufas, porphyries, and trachytes, described as occurring below, reappear, giving the same fantastic appearance to the scenery. These rocks, with trap and scoria, extend from the river to Chimney Peak.

Chimney Peak is a remarkable picturesque double pinnacle which crowns a mountain chain, probably the northwestern prolongation of the middle range of the Purple Hills. Like the other peaks of the range it is composed of trap, and affords a striking example of the tendency to form columnar summits exhibited by all the mountains of this vicinity. Dome mountains on the east of the Colorado, present the same features in nearly an equal degree. The mountains which have this form are all trappean in character, and doubtless owe their peculiar outlines to the manner in which this material yields to the action of the elements. The trap is usually more or less columnar in structure, the cleavage planes which bound the columns being perpendicular to the cooling surface. When, as most frequently occurs, these planes are vertical, by the erosion of rains and flowing streams, perpendicular walls are formed, and large masses usually exhibit mural faces. This will account for the peculiar outline which many of the trappean summits of the mountains of the Colorado basin present. Their great altitude, as compared with the mass of the ranges which they crown, is doubtless due to the resistance offered by their material to the atmospheric influences which have removed perhaps several hundred feet of the more yielding tufas and trachytes once surrounding them.

About the bases of some of the isolated mountains of the Colorado basin the material washed from the sides and summits has accumulated, and where these detrital slopes have been opened in the beds of the 'washes' I have described, I was able roughly to measure the amount of denudation the mountains had suffered. From these data it would appear that many of them have once been fully twice their present size.

At Precipice Bend and Barrier islands the river impinges against huge masses of red trachytes, west of which the highly colored rocks before described are very conspicuous, and extend for many miles along the base of Chimney Peak range.

"At intervals the sedimentary rock is covered with erupted materials, basaltic trap, scoria or ashes; and at several points are cones, once minor volcanic vents, and the sources from which these igneous rocks were de-



rived. Near our camp 84 is the most interesting group of these craters met with on our route, (see p. 402). Several of them are still very perfect in form, and long sinuous lines of black lava run down their sides—graphic records of their latest eruptions."

But we have neither time nor space to speak farther of this interesting and valuable report. Nearly 15,000 copies of it have been published by the Government, and it will doubtless be accessible to all who may wish to examine it for themselves. The authors have acquitted themselves with honor, the typography is clear and excellent, with very few errors, but with the exception of the scenic views and the topographical maps, the engravings are many of them quite poor. The maps which accompany this Report do great credit to the artistic skill and originality of Mr. Egloffstein, who has adopted a system of ruled tints by which the light sides of the mountains are relieved and the comparative altitudes of different levels exhibited, producing a most beautiful and effective picture of the topography, resembling a relief model. The maps are duplicated for the geology, the tints of the various formations being lightly and skillfully washed over them. The fossils are done in a harsh mechanical style of ruling, with little or no delicacy of tinting, and fail to exhibit to the eye of the Palæontologist their proper specific characters. There are comparatively few engravers capable of executing such illustrations in a style to be of service in the identification of species and creditable to the artistic skill of the country, and such persons rarely visit the seat of government to scramble after contracts; the consequence is that this kind of work, in too many cases, falls into incompetent hands. Proofs of engravings of objects of natural history ought *always* to be submitted to the careful inspection of the author or to some competent naturalist who shall have the power to accept or reject them, which has been, hitherto, seldom or never done.

We think we see in the future the dawn of better things, when mere political influence shall not control the publication of those scientific works with the proper execution which the national honor is inseparably connected.

ART. XLI.—*Enumeration of the Plants of Dr. Parry's Collection in the Rocky Mountains in* 1861; by ASA GRAY. Continued from p. 243.

SINCE the first part of this Enumeration was published, Dr. J. D. Hooker's most interesting memoir, entitled "Outlines of the Distribution of Arctic Plants," has been received. This is of great importance in the study of any alpine or subalpine collection like the present, and has given occasion to a few remarks in the following pages. The memoir itself I expect to give some account of hereafter.

No. 79. Mr. Black, the obliging Curator of the Hookerian Herbarium, calling my attention to this number, enables me to correct an obvious error in my naming, in the first part of this enumeration. The plant is not *Ranunculus glaberrimus*, Hook., but an abbreviated subalpine state of *R. alismæfolius*, Geyer (the same as No. 306 of his collection), to which Bentham refers the *R. Flammula* of American authors.

I am well satisfied to see that Dr. Hooker, in his important paper on the Distribution of Arctic Plants, reduces *R. Eschscholtzii* to *R. nivalis*, L. Some specimens of Parry's No. 80 probably belonged to *R. affinis*.

104. *Cleomella tenuifolia*, Torr., from the district in which Dr. James discovered this species, so long taken for the original *C. Mexicana*.

105. *Cleome integrifolia*, Torr. & Gray. The *C. serrulata* is probably a nonentity, or a mere variety of this.

106. *Viola biflora*, L. This arctic-alpine species of the Old World had been traced all the way round to N. Japan and Kamtschatka, but was not before known as American, unless perhaps recently to Dr. Hooker, who has recorded it in his Tabular View,—perhaps on Dr. Parry's specimens, which may have reached him in time; or perhaps Bourgeau may have met with the plant.

107. *Viola Muhlenbergii*, Torr.; with some pubescent specimens belonging to the next.

108. *Viola Muhlenbergii*, var. *pubescens*, passing into *V. adunca*, Smith (*V. longipes*, Nutt.); which, except in its longer (seldom crooked) spur, as closely answers to the *V. arenaria* and *pumila*, as the ordinary *V. Muhlenbergii* does to the *V. sylvatica*, of the Old World. *V. adunca* should therefore have been added to the synonyms adduced by Dr. Hooker, in bringing all of this group under *V. canina*. Parry's specimens answer well to Bourgeau's from Saskatchawan.

109. *Viola Nuttallii*, Pursh; from the plains.

110. *Viola palustris*, L. From the alpine region, apparently, and the true *palustris*. The plant of our White Mountains is rather *V. epipsila*, Ledeb. Dr. Hooker goes a step too far in referring our *V. blanda* (with its lanceolate sepals and white flowers) to *V. palustris*. Our difficulty is to keep *V. blanda* clear of *V. primulæfolia*, and that clear of *V. lanceolata*.

111. *Geranium Carolinianum*, L.

112. *Geranium Richardsonii*, Fisch. & Mey.: "var. stylis profundius divisis nudiusculis." Engelm.

113. *Geranium Fremontii*, Torr.: "var. *Parryi;* caulibus pedunculisque patenter glanduloso-villosis; foliis minus profunde incisis, laciniis ultimis dentibusve ovatis obtusiusculis." Engelm.—The deflorate pedicels are sometimes declined.

114. *Gaura coccinea*, Nutt.

115. *Œnothera lavandulæfolia*, Torr. & Gray.

116. *Œnothera albicaulis*, Nutt., with pinnatifid leaves.

117. The same with undivided leaves.

118. *Stenosiphon virgatus*, Spach.

119. *Epilobium tetragonum*, L. Just like Swedish specimens.

120. *Epilobium alpinum*, L. The same genuine form was gathered by Mr. H. Engelmann at Bridger's Pass.

121. *Epilobium alsinifolium*, Vill. The same as the larger form in the alpine region of the White Mountains of New Hampshire. Dr. Parry notes it as probably a form of the last, and so we have regarded it.

122. Nearly the same as No. 119, but nearly smooth.

123. *Epilobium latifolium*, L. Perhaps its most southern station.

125. *Epilobium paniculatum*, Nutt.

124. *Gayophytum ramosissimum*, Torr. & Gray.

126. *Mentzelia albicaulis*, Dougl.

127. *Mentzelia* (*Bartonia*, Nutt.) *nuda*, Torr. & Gray.

128. *Sedum Rhodiola*, L. The female plant. "Along the borders of alpine brooks."

129. *Sedum rhodanthum* (sp. nov.): floribus hermaphroditis plerisque tetrameris pedicello plus duplo longioribus; sepalis linearibus; petalis læte roseis lanceolatis sensim acuminatis stamina (oppositopetala eis infra medium adnata) paullo superantibus; ovariis rectis; stylis filiformibus: cæt. ut in *S. algido* videtur. "High alpine region in moist places, at greater elevation than the preceding: fl. July." Petals nearly half an inch long, of a clear and deep rose-color, while those of *S. algidum*, of the Altaic Alps are described and figured as yellow, or dull rose-color with age, and blunt. As the stamens are adnate to the petals nearly as high as in *S. algidum*, it cannot be the doubtful *S. euphorbioides* of the elder Schlechtendal, from Arctic Siberia, which Ledebour, who took it up, regards as a possible variety of *S. algidum*.

130. *Sedum stenopetalum*, Pursh. All our species should be elaborated anew.

131. *Silene Drummondii*, Hook. The species of this group are much confused in the Flora of North America.

134. *Silene Scouleri*, Hook.

137. *Silene Menziesii*, Hook.

132, 133. *Lychnis apetala*, L. (*L. brachypetala*, Hornem.) Uniflorous and pauciflorous forms.

135. See *Gentiana*, among the Monopetalæ.

136. *Stellaria longifolia*, Muhl.

138. *Cerastium vulgatum*, the var. *Behringianum*, and *C. arvense*, L. mixed.

139. *Sagina Linnæi*, Presl.

140. *Arenaria Fendleri*, Gray, Pl. Fendl.

141. *Arenaria arctica*, Stev., var. γ, Torr. & Gray.

142. *Claytonia arctica* (Adams), var. *megarhiza:* foliis caulinis lanceolato-spathulatis seu lineari-spathulatis basi attenuatis quasi petiolatis; racemo intra folia subsessili (an semper?). *C. megarhiza*, Parry in litt., a name very probably to be adopted. "High alpine stations, extending to the crest of the snowy range; flowers from June to August. Grows in crevices of rocks, its large tap root penetrating to a great depth. Flowers, profuse, white with greenish-purple veins."—The large perpendicular root (about an inch in diameter), with the radical leaves and flowers, are just as in large specimens of *C. Joanneana*, Rœm. & Schult. (*C. acutifolia*, Ledeb. Fl. Alt. and Ic. Pl. Ross., t. 372, non Pall., Willd.) of which, confirmed by Trautvetter in Fl. Taimyrensis, I conclude that *C. arctica*, Adams (published two years earlier) is only a more arctic form. But the leaves of the cauline pair in our plant are much longer and narrower, tapering into a petiole, and they closely subtend the short raceme; wherefore this fine plant would most naturally, and perhaps more correctly, be taken as specifically distinct from the arctic-alpine Siberian one; in which view Dr. Parry's name is appropriate for it. I have seen no intermediate form. But after the experience we have had of the variability of the foliage of Claytonias, I prefer to risk the view here taken.

Aided by Dr. Parry's excellent specimens, I have now reviewed my MS. notes upon Pursh's *C. lanceolata* (which has been such a puzzle), and upon the related perennial species. It will be seen that Pursh's name, descriptive phrase, and figure do not accord; also that he adds, "*Pall. MSS.*," and states that he found in herb. Lamb. "a specimen collected by Pallas in the eastern part of Siberia, perfectly agreeing with the present species,"—doubtless the *C. Joanneana*, Roem. & Sch., of which I have seen Pallasian specimens. I have reason to think that Pursh's plate was made up from this Pallasian specimen and from the materials he had from Lewis, which last also perhaps comprised portions of two species. The radical leaves figured, which certainly are are not "lanceolate," are probably from the Siberian plant; the cauline of the plate are are not "ovate," and are narrower than I have observed them in any Siberian specimens,—in which, however, they are said to vary from ovate to elliptical: the naked corm, resembling that of *C. Virginica*, must belong to that *Claytonia* of the Rocky Mountains, &c., which is so nearly related to *C. Caroliniana*, but with sessile, oblong, linear-oblong, or even linear-lanceolate leaves, when dry 3-nerved from the base, i. e., the *C. lanceolata* of Hooker's Flora, and the *C. Caroliniana*, var. *sessilifolia*, Torr. in Pacif. R. R. Rep., 4, p. 70. Now, my notes, made in the year 1839, upon Pursh's materials in the Lambertian herbarium, state that the specimen there ticketed *C. lanceolata* by Pursh is the tuberiferous or corm-bearing plant, above-mentioned, and which may therefore, if permanently distinct from its eastern relatives, retain that name. With it is a specimen, ticketed by Pursh "*C. lancifolia*," having lanceolate-ovate cauline leaves. This may have furnished the model for the flowering stem of Pursh's figure, but it is not accompanied by any root or any radical leaves; while, as to the corm-bearing

species, these bear only single or very few radical leaves, and mostly none at all when the corm produces its flowering stem. The *C. lanceolata* of Hooker's Flora, as to the specimens, so accurately characterized in his remarks, is the same cormiferous species as Pursh's. But his specific phrase and the closing remark are evidently more or less influenced by Pursh's figure. The present discovery of a great tap-rooted *Claytonia* in the Rocky Mountains renders it not unlikely that Lewis and Clarke may have gathered the two species,—this without the root,—and that Pursh may have confounded them. However that may be, the names of the species concerned should stand as follows:—

C. LANCEOLATA, Pursh, fide herb., &c., for the corm-rooted plant of the Rocky Mountains and California, with sessile narrow leaves. Yet this is quite likely to prove a variety of *C. Caroliniana* (which also inhabits the valleys of the Rocky Mountains, both in New Mexico and in the British possessions), and that again runs insensibly into *C. Virginica*. It would appear that *C. lanceolata* extends to Kotzebue's Sound (Hook. & Arn., Bot. Beech. Voy., p. 123), and to the opposite Asiatic coast (Cham. in Linnæa, 6, p. 563). But Hooker and Arnott's *C. Virginica* from the latter region is probably

C. TUBEROSA, Pall. in Willd. Rel., ex Schult. Syst. 5, p. 436. *C. Virginica*, Willd. Herb. If I may rely on my notes taken in the herbarium of Willdenow in the year 1839, this plant of Pallas, with leaves as narrow as those of our *C. Virginica*, has the cauline ones closely sessile, and a *fusiform caudex* (so that the *C. Virginica* of Fenzl in the Flora Rossica is factitious); and I suppose that *C. Eschscholtzii*, Cham. l. c., is the same plant. Also that *C. acutifolia*, Pall. in Willd. Rel. l. c., is a broader leaved form of it, verging towards

C. ARTICA, Adams. This species (to which I dubiously append Parry's No. 142) was founded upon the most reduced and arctic state of the species to which belong *C. Sibirica*, Pallas in herb. Willd., but not of Linnæus,* *C. Joanniana* of Schultes, *C. acutifolia* of Ledebour, and *C. arctica*, var. *maxima*, of Chamisso.

143. *Talinum pygnæum* (sp. nov.), Gray in coll. H. Engelmann, Exped. Bryan. I know not if this is yet published. Parry's specimens closely resemble those gathered by H. Engelmann at Bridger's Pass, in the year 1856, except that they are larger and finer. It is an acaulescent species, with a fusiform perennial root, the crown bearing a cluster of linear or spatulate-linear leaves, with one-flowered and mostly bibracteolate peduncles in their axils.

144. *Ceanothus Fendleri*, Gray, Pl. Fendl.

145. *Ceanothus velutinus*, Dougl., near the var. *lævigatus*, Torr. & Gray.

146. *Berberis Aquifolium*, Pursh, var. *repens*.

147. *Papaver alpinum*, L. (*P. nudicaule*). High alpine.

148. *Callirrhoë involucrata*, Gray, Pl. Fendl., &c.

149. *Ribes lacustre*, Poir. An alpine form: "the common alpine

* The statement respecting the *C. Sibirica* of the Linnæan herbarium, made in the Flora of North America, 1, p. 476, and for which I am responsible, is not borne out by my MS. notes, which, on the contrary show that *C. Sibirica*, L., is entirely *C. alsinoides*, Sims.

Gooseberry, fruit reddish, hispid: flowers brownish," fewer in the raceme than in the common plant. This is probably *R. setosum*, Dougl.; at least it is the plant cultivated under that name, many years ago, by Loddiges.

150. *Ribes cereum*, Dougl. "Fruit reddish or amber-colored, insipid."

151. *Ribes hirtellum*, Michx. "Fruit dark purple, very acid."

152. *Ribes prostratum*, L'Her.

153. *Rhus trilobata*, Nutt., a variety of *R. aromatica*.

154. *Archangelica Gmelini*, DC. Dr. Hooker, in his paper on arctic plants, has referred not only the *A. littoralis* or *Norvegica* of N. Europe, but also *A. Gmelini* and *A. atropurpurea* to *A. officinalis*. I have already in more than one place insisted that *A. Gmelini* (the *Physolophium* of Turczaninow, *Cœlopleurum* of Ledebour, &c.) is a good *Archangelica;* but for want of good fruit of *A. officinalis* and *A. littoralis* I am unable to judge whether the latter connects *A. Gmelini* with the former. But I have no question (theories of derivation apart) that our *A. Gmelini* and *A. atropurpurea* are abundantly distinct, as well in their fruit as in their whole appearance. "Growing in truly alpine situations."

155. *Berula angustifolia*, Koch; a strict form.

156. *Conioselinum Fischeri*, Wimm. Just like the plant of the Northwest coast, and the *C. Tartaricum* of North Europe. But also not different, as far as I can see, from *C. Canadense*, so that we may extend the synonymy and range as given by Dr. Hooker. It ranges south to the mountains of New Mexico east of the Rio Grande, and in the Alleghanies to North Carolina.

Leptotænia dissecta, Nutt., was gathered, a single specimen, at the foot of the Rocky Mountains.

157. *Cymopterus terebinthinus*, Torr. & Gray, var. *C. fœniculaceus*, Nutt.

158. *Cymopterus alpinus* (sp. nov.): caudice cæspitoso; foliis pinnatisectis, pinnis 3–5 approximatis 3–7-partitis, segmentis lineari-lanceolatis acutiusculis vel mucronatis integerrimis seu inferioribus 2–3-fidis; scapo 2–4-pollicari umbellam subcapitatam gerente; involucellis subunilateralibus 5–7-partitis, segmentis linearibus seu lanceolatis viridibus flores aureos adæquantibus; calycis dentibus lanceolato-subulatis persistentibus; alis fructus æqualibus suberoso-incrassatis vix undulatis; valleculis 1–2-vittatis, commissura 4-vittata; carpophoro nullo. "On high alpine ridges, along with *Primula angustifolia*, one of the earliest plants to flower." Leaves rather shorter than the scapes, glabrous, not glaucous, the margins minutely ciliolate-scabrous; segments $1\frac{1}{2}$ or 2 lines long, in the smaller specimens only three in number. Fruit (of which very little was gathered) only 2 or 3 lines long. This is most probably the Umbelliferous plant collected by Dr. James in this same district, without fruit, and described in Dr. Torrey's account of James's collection, p. 207, but not named.

160. *Cymopterus montanus*, Nutt.

159. *Thaspium montanum*, var. *tenuifolium*, Gray, Pl. Wright.

161. Probably *Thaspium montanum*, Gray, Pl. Fendl. In flower only.

162. *Pachystima Myrsinites*, Raf. (*Myginda myrtifolia*, Nutt.)

163. *Saxifraga punctata*, L. (*S. æstivalis*, Fisch.)

165. *Saxifraga flagellaris*, Willd.; with scanty runners.

164. *Saxifraga Hirculus*, L. A very condensed, cæspitose, high-alpine form, the flowering stems barely two inches high, perhaps the same as *S. propinqua*, Brown, from the arctic shores. *S. serpyllifolia* of Pursh seems very near this, with smaller flowers, &c.

166. *Saxifraga Hirculus*, L. A small form, only 2 or 3 inches high, but quite like the common Arctic American specimens.

167. *Saxifraga cernua*, L.

168. *Saxifraga bronchialis*, L.

169. *Saxifraga nivalis*, L. Dr. Hooker might properly have cited *S. Virginiensis* as the temperate form of this species, and *S. vernalis* as a connecting form. *S. Virginiensis* stands independently in Hooker's list, resting on *S. reflexa*, Hook., from the shores of the arctic sea. I have never seen *S. reflexa;* but, from the character (especially the upwardly dilated filaments) and the fine figures in the Flora Boreali-Americana, I suppose that it is rather a form of *S. Dahurica*, to which *S. flabellifolia*, R. Br., also belongs.

A solitary specimen, from alpine brooks, may be *S. heiracifolia*, but it is too young for determination.

170. *Saxifraga cæspitosa*, L., var.; a very condensed alpine form: *S. uniflora*, R. Br.

171. *Mitella* (*Mitellaria*) *pentandra*, Hook.

172. *Heuchera bracteata*, Seringe. An interesting rediscovery of one of plants before known only from a single specimen in Dr. James's collection. According to Dr. Torrey, it accords with the original plant, but is larger-leaved. "Common in crevices of rocks, from the base of the mountains to alpine situations."

173. *Heuchera parvifolia*, Nutt.; a small state. "Strictly alpine, always exhibiting its close spikes, which are never elongated as in No. 174.

174. *Heuchera parvifolia*, Nutt., the taller form, exactly Fendler's No. 264, and Wright's 1098. "Valley of Clear Creek, common." Dr. Parry remarks: "I did not suspect this to be a variety of the former: its loose habit and long inflorescence seem to distinguish it; and no intermediate forms were noticed."

175. *Jamesia Americana*, Torr. & Gray; from the original habitat. The genus was founded, in the Flora of North America, upon a specimen so imperfect that it was omitted in the original account of Dr. James's collection. It is now well known, having been collected by Fendler, &c.; and, as it proves, the discoverer (now recently deceased) is commemorated by a most distinct and interesting genus.

176. *Trifolium dasyphyllum*, Torr. & Gray. Less downy than Dr. James's plant is described, the flowers considerably smaller than those of *T. alpinum*.

177. *Trifolium nanum*, Torr. "On the crest of high alpine ridges, in dense patches." This and the preceding are interesting re-discoveries.

178. *Trifolium Parryi* (sp. nov.): Involucrarium: glabrum, surculosum, subcaulescens; scapo 3–4-pollicari basi foliato; stipulis ovatis scariosis; foliolis oblongis argute dentatis; involucro scarioso 5–7-par-

tito capitulo plurifloro multum breviore, segmentis ovatis obtusis; calycis corolla rubro-purpurea subtriplo breviore, dentibus lato-subulatis tubum campanulatum subæquantibus; legumine sessili 3–4-spermo. "On high, grassy, alpine slopes. Flowers bright-red and purple, conspicuous." A well-marked species, very different from any of our involucrate species except *T. fucatum*, which has similar, but larger, stipules and corollas. Leaflets 6 to 12 lines long. Flowers 20 or more in the head, about 9 lines long, the corolla persistent and somewhat ampliate after flowering.

179. *Oxytropis splendens*, Dougl.

180. *Astragalus oroboides*, Hornem. *Phaca oroboides*, DC. *P. elegans*, Hook. I possess a mere fragment, without fruit, of the original *Phaca elegans* of Hooker's Flora; but I have a fine specimen, so named, from Bourgeau's Saskatchawan collection; and "*Phaca* No. 5" of the same collection is just like my original specimen of *P. elegans*, and like *P. oroboides* from Labrador communicated by Dr. Steetz. The latter and European specimens have rather less slender calyx-teeth; but no other difference is manifest. The elliptical and sessile legume has the dorsal suture more or less intruse. "*Phaca* No. 2" of Bourgeau's collection in the Rocky Mountains is probably a variety of *A. alpinus*, but has a shorter stipe to the legume and longer, very slender calyx-teeth.

181. *Astragalus* (*Phaca*, Hook.) *nigrescens*, Gray. *Homalobus dispar*, *multiflorus*, and *nigrescens*, Nutt.

182. *Astragalus alpinus*, L. *Phaca astragalina*, DC.

183. *Oxytropis Lamberti*, Pursh., if the flowers are purple as they seemingly are. Also *O. sericea*, Nutt., I presume.

184. *Astragalus*, near *glareosus*, Dougl., but the raceme many-flowered. Fruit not seen.

185. *Astragalus* (*Phaca*, Hook.). *Pectinatus*, Gray.

186 and 189. *Oxytropis Lamberti*, Pursh.

187. *Lathyrus ornatus*, Nutt. On the lower Platte.

188. *Lathyrus linearis*, Nutt.

189. *Astragalus gracilis*, Nutt.

190. *Astragalus* (*Orophaca*) *sericoleucus*. *Phaca sericea*, Nutt. Sand hills of the Upper Platte, May: in flower.

191. *Oxytropis nana*, Nutt. (*O. arctica*, var.?). "High valleys, rooting in granitic sand, in shade of *Pinus Banksiana*: rare."

192. *Dalea alopecuroides*, Willd. Doubtless from the plains.

193. *Astragalus Parryi*, (sp. nov.): cæspitoso-multicaulis e radice crassa, humifus, laxe villosus; stipulis fere discretis liberis ovatis, superioribus ex ovato lanceolato-subulatis; foliolis 15–21 ovalibus supra glabrescentibus glabrisve; pedunculis folium subæquantibus; racemo brevi 6–10 floro; floribus (6–8 lin. longis) subpatentibus; calycis dentibus attenuato-subulatis tubo oblongo-campanulato æquilongis; corolla ochroleuca ("viridulo-lutea") carina apice purpurascenti; legumine pollicari hirsuto coriaceo subinflato ovato-lanceolato acuminato incurvo uniloculari, suturis utrisque leviter intrusis. *A. succumbens*, Torr. & Gray, in Pacif. R. Road Rep. 2, (coll. Pope) p. 163, non Dougl. "Common in dry gravelly banks along Clear Creek: prostrate, with decumbent branches, matting the ground." Capt. (now General) Pope collected it in flower on the Llano Estacado, and Mr. Gordon in the same condition in the

Raton Mountains. It is with great unwillingness that one adds another species to this great genus, while several in the books are still imperfectly known. I had before referred this to *A. succumbens*, but the forming fruit of Parry's specimens shows that it is very different, and more allied to *A. glareosus*, Dougl. (*A. argophyllus*, Nutt.) yet it can hardly have been confounded with that species.

194. *Hosackia Purshiana*, Benth. Valley of the Platte.

195. *Dalea laxiflora*, Pursh. From the plains.

196. *Sophora sericea*, Pursh. Probably from the plains.

197. *Thermopsis rhombifolia*, Nutt.

198. *Psoralea lanceolata*, Pursh.

200. *Lupinus*. The same as Fendler's No. 168, which was doubtfully referred to *L. laxiflorus*. It cannot be named correctly until the related species are revised.

201. *Prunus* (*Cerasus*) *Virginiana*, L.

202. *Sibbaldia procumbens*, L.

203. *Dryas octopetala*, L.

204. *Geum rivale*, L. A specimen of this in fruit (in herb. Durand) collected at Eureka by Mr. Howard, has the head of carpels sessile; but still it appears to be only *G. rivale*, not *G. geniculatum*.

205. *Geum* (*Sieversia*) *Rossii*, Seringe. Large forms, a span high.

206. *Spiræa discolor*, Pursh. (*S. ariæfolia*, var. *discolor*, Torr. & Gray.)

207. *Spiræa opulifolia*, L., a small-leaved form, near the var. *pauciflora*, Torr. & Gray.

208. *Rosa blanda*. Ait.

209. *Cercocarpus parvifolius*, Nutt. The plant so long ago collected by Dr. James, but mistaken for the Mexican *C. fothergilloides*.

210. *Rubus deliciosus*, Torr. "A profusely-flowering shrub, abundant from the base of the mountains to the upper valleys, associated with *Jamesia*. Flowers white, never purplish. Fruit small, coarse-grained and insipid, ripening few largish grains." With Dr. Parry, I cannot doubt that this is James's *R. deliciosus*, notwithstanding the discrepancies. Those relating to the berries are principally a matter of taste, under different circumstances. The color of the petals was probably mistaken by the describer. To this species accordingly belongs my *R. Neo-Mexicanus*, Pl. Wright.

211. *Rubus Nutkanus*, Moçino.

212. *Rubus Idæus*, L. "Alpine."

213. *Potentilla fissa*, Nutt. In the mountains.

214, 215. *Potentilla nivea*, L. Slender forms.

216, *Potentilla Pennsylvanica*, L., var. *strigosa*.

217. *Potentilla concinna*, Richards.? a large form. At least a solitary specimen of undoubted *P. concinna*, from a higher station, is ticketed by Dr. Parry as a dwarf form of No. 217.

218, 219, 220, are forms of *Potentilla diversifolia*, Lehm., including *P. glaucophylla* and *P. Drummondii*, Lehm., and probably some others. The whole group requires complete revision and much reduction.

221. *Adoxa Moschatellina*, L.

(*To be continued.*)

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY.

1. *On the employment of the diffusion of liquids in chemical analysis.*—GRAHAM has applied the principle of diffusion with great success to the separation of substances of different diffusive power and has in some cases obtained results of remarkable accuracy. The author terms the process of separation in question *Dialysis.* Those substances which are uncrystalline in structure and which possess an extremely low diffusive power Graham calls *colloid*, and their state or condition the *colloidal* form of matter. Gelatin may be considered the type of this class of bodies. The colloid condition is strongly contrasted with the crystalline, or as Graham terms it, the *crystalloid*, the difference being not merely in the low diffusive power of the former, but also in the fact that colloids exhibit an intermediate state between solubility and liquidity, in many cases at least, and may serve as a medium for liquid diffusion like water itself. Colloids are further characterized by their changeable nature: fluid colloids readily become gelatinous or *pectose*, or pass back again from the pectose to the fluid state. The soluble hydrates of silica, alumina and analogous metallic oxyds, starch, dextrin, gum, albumen, gelatin, casein, &c., are colloids. Graham considers the colloidal form to be the dynamic while the crystalloidal is the statical form of matter.

A very simple method of separating bodies by diffusion consists in placing the mixture in a cylindrical glass vessel, five or six inches in depth, and filling the vessel with water very carefully so as not to disturb the matter at the bottom. After a few days the upper layers of water may be drawn off by means of a pipette and contain the most diffusible substances in solution.

For practical purposes it is convenient to employ an apparatus consisting of a flat round vessel in the shape of a sieve, the rim of which consists of gutta percha, and the bottom of parchment paper: the diameter of the vessel may be from eight to twelve inches, and its depth three inches. To illustrate the use of this apparatus, a mixed solution of gum and sugar may be introduced into the vessel so as to cover the bottom about half an inch deep, and the vessel allowed to float upon a larger quantity of water. In the course of twenty-four hours, all the sugar will be found to have passed through the membrane, and so free from gum that the solution is scarcely rendered turbid by basic acetate of lead, and yields by evaporation crystallized sugar.

Graham explains this action by supposing that the sugar takes up the water which the colloidal membrane has absorbed, and in this manner obtains a medium for diffusion, while the gum, which is a colloid, cannot separate the water taken up by the membrane and consequently cannot pass through. The author applies the method of dialysis to the preparation of colloidal substances in a state of purity, and even in many cases to analytical separations, as for example, to the separation of arsenous acid and other poisons, from liquids which contain organic matters. Thus if a few milligrammes of arsenous acid be introduced into

the dialytic apparatus with milk or other organic substances, after twenty-four hours the greater part of the arsenous acid will be found in the water beneath. This liquid, which the author calls the *diffusate*, is so free from organic substances that the arsenic may be precipitated directly by means of sulphuretted hydrogen.

If to a solution of albumen from eggs, acetic acid be added and the liquid be submitted to dialysis, the alkaline and earthy salts are rapidly diffused, and after three or four days, the albumen leaves no trace of ash. Albumen prepared in this way has a faintly acid reaction and still contains the sulphur which belongs to its constitution.

Half a liter of urine gave after a dialysis of twenty-four hours, the crystalloid substances contained in it, to the external water; this last on evaporation in a water-bath gave a white saline mass, from which alcohol extracted urea in such a state of purity as to crystallize on evaporation.—*Ann. der Chem. und Pharm.*, cxxi, 1, and *Phil. Trans.*, 1861.

In a note to the above paper Liebig calls attention to the fact that Graham's explanation of the diffusion of saline solutions through porous media, is identical with that which he had himself given in a paper on the causes of the motion of liquids in the animal body published in 1848, and which Graham appears not to have seen. Liebig further illustrates the importance of the method in examining the animal fluids, by a statement that flesh-broth, obtained by heating two parts of flesh with one of water in a water-bath, gave on dialysis an almost perfectly colorless diffusate, from which after concentration in a water-bath, very pure crystals of creatin were deposited, the other crystallizable substances in flesh being also present in the liquid. By a similar process, Liebig detected alloxan in a mucous discharge from the bowels. The importance of the method in the study of the chemical constitution of animal and vegetable secretions, can hardly be over estimated. W. G.

2. *On the determination of the density of vapors at low temperatures.*—Playfair and Wanklyn have given a method of determining the densities of vapors which depends upon the fact that permanent gases possess the property of converting vapors into true gases, or as the authors express it more accurately, the presence of a permanent gas acts upon a vapor in such a manner that its co-efficient of expansion for temperatures which lie near its point of evaporation, approximates to the co-efficient which obtains at the highest temperatures.

The authors remark that the mixture of a permanent gas may aid in distinguishing between the cases in which a vapor has an unusually high co-efficient of expansion and those in which an actual chemical change occurs. It is also possible by the employment of a permanent gas to determine the vapor densities of substances, which cannot be heated to the boiling point without decomposition.

In the case of those substances which may be heated above their boiling points, the authors employ Gay-Lussac's process for the determination of the vapor density. A slight modification of the process is however necessary. Before the glass bulb containing the weighed substance is introduced into the apparatus dry hydrogen gas is thrown up into the graduated tube and its volume measured with the usual precautions. In the subsequent calculation, the volume of the hydrogen reduced to the

normal temperature and pressure, must be subtracted from the reduced volume of the mixture of gas and vapor.

When the substance cannot be heated to its boiling point, the authors employ a process which is similar in principle to that of Dumas, but different in execution. Two bulbs, holding together about 300 cubic centimeters, are connected and drawn out on either side into a narrow tube. On one of these narrow tubes, three or four small bulbs are blown; the other is bent upward and then horizontally. The apparatus is weighed in dry air, introduced into a bath and a current of dry hydrogen gas passed through. The bath is then to be filled with warm water and the hydrogen current interrupted for a moment, in order that a small quantity of substance may be introduced into the apparatus. The substance is partially volatilized in the current of hydrogen and passes in the form of vapor into the large bulbs. The temperature of the bath is kept uniform in different parts and very gradually increasing. When the temperature has nearly reached that at which the determination is to be made, the current of gas is to be nearly interrupted, so that the bulbs contain less vapor than is sufficient to saturate the gas at the temperature of closing. The water is now allowed to flow out of the bath till the bends of the side tubes are uncovered, the bulbs remaining covered. The hydrogen current is then interrupted and the bends of the outer tubes sealed with the blowpipe, the temperature and pressure being observed. The volume of the apparatus is found by filling it with water and weighing, after determining the volume of the hydrogen contained. This is done by breaking off one of the ends under water, which rises into the bulbs, absorbing the vapor and leaving the hydrogen. The bulbs must now, without any change of temperature, be taken from the water and weighed with the contained water. The difference between this weight and the weight of the bulbs when completely filled with water, gives the weight of the contained hydrogen and consequently its volume; the pressure is the height of the barometer minus the column of water which enters the bulbs; the temperature is that of the water.

The authors have applied their experiments to acetic acid and other substances. At low temperatures, the vapor density of acetic acid is nearly 4·00, no matter how much hydrogen may have been employed. At higher temperatures, the vapor density approaches the number 2·00, while it is unnecessary to heat as strongly as in the experiments of Cahours.—*Ann. der Chem. und Pharm.*, cxxi, 101.

3. *On the analysis of spectra colored by metallic salts.*—Debray finds that the colored spectra obtained in the experiments of Bunsen and Kirchhoff may be projected upon a screen and rendered visible to a large audience by employing the flame of the oxyhydrogen blowpipe as the source of heat, instead of the ordinary gas burner. The metallic salt may be introduced into the flame by means of a little piece of gas-retort carbon. By employing the so-called Drummond's light, the inversion of sodium line D may also be projected on a screen; it is only necessary that the light should pass through the flame of an alcohol lamp containing salts in solution.—*Comptes Rendus*, liv, 169. W. G.

4. *On the spectra of phosphorus and sulphur.*—Seguin has examined the spectra produced by volatilizing sulphur and phosphorus in a current

of hydrogen and then passing the sparks from a Ruhmkorff's coil through the mixture of gas and vapor. The spectrum of phosphorus as thus obtained contains a red ray, an orange ray almost as brilliant as the red, two green rays less marked at the extremity of the visible portion of the green; after a comparatively dark space a blue-green ray, and then blue or violet rays which are not well defined. The orange and the two green rays appear or disappear according as the recipient containing the phosphorus is heated or cooled: they are therefore characteristic of phosphorus. The red and blue-green rays appear to belong to hydrogen though the phosphorus may contribute to the red.

Phosphuretted hydrogen gives the red, orange and blue-green rays, the two green rays not being apparent. Terchlorid of phosphorus mixed with hydrogen gives the orange, red and blue-green rays, as well as blue and green rays which belong to chlorine, and violet rays which may belong to both elements. The spectrum of the vapor of sulphur has a remarkable brilliancy when the temperature is high. It presents a red ray; three strong green rays almost equidistant, the first and second appearing almost yellow from their lustre, the third less vivid and apparently composed of finer rays; a greenish-blue ray, two blue and two violet rays. The three green rays are most characteristic: they are found also in the spectra of sulphydric and sulphurous acids. The author employed in his experiments a simple prism without telescope.—*Comptes Rendus*, liii.

W. G.

5. *On a new method of detecting and preparing the organic alkaloids.*—Erdmann and von Uslar have given a new method of separating the organic alkaloids which depends upon the fact that the free bases are easily soluble in hot amylic alcohol, while their chlorhydrates are so insoluble that they may be separated from the amylic solution by simply shaking this with water containing chlorhydric acid in solution. In preparing the alkaloids the material is to be extracted with chlorhydric acid, the extract treated with ammonia to set free the bases, and evaporated. The alkaloid may then be dissolved with hot amylic alcohol, the solution is to be shaken with water containing chlorhydric acid, which gives a pure solution of the chlorhydrate, while fatty and coloring matters remain dissolved in the amylic alcohol, which may be separated mechanically from the watery layer.—*Ann. der Chem. und Pharm.*, cxv, p. 121.

W. G.

6. *Determination of carbonic acid in organic analysis.*—Mulder replaces in organic analysis the ordinary potash bulb apparatus by a tube filled with soda-lime. The apparatus which he employs consists of an ordinary combustion tube with a chlorid of calcium tube attached. To this last is attached a small U-shaped tube with small pieces of glass and from six to ten drops of concentrated sulphuric acid; after this comes a U-shaped tube, seven-eighths of which are filled with soda-lime, the other eighth with chlorid of calcium. Lastly, a tube filled with pieces of caustic potash is added; this is not weighed, but serves to prevent the influence of the air.

The chlorid of calcium tube and the U-shaped tube with the sulphuric acid are weighed together: the sulphuric acid tube enables the operator to watch the progress of the analysis. The soda-lime absorbs the car-

bonic acid completely; the chlorid of calcium serves to prevent the escape of water.

A U-shaped tube containing soda-lime and chlorid of calcium and weighing about forty grammes, will usually answer for two successive analyses; it is better, however, in the second analysis to add another and similar tube which should also be weighed before and after the analysis. When a current of oxygen is used to complete the combustion, it is necessary before weighing to fill the tubes with oxygen. If in the progress of the analysis, the sulphuric acid becomes brown, it may be inferred that volatile carburets of hydrogen have escaped combustion. The author asserts that this may be completely avoided by filling the combustion tube completely with oxyd of copper and by not making a canal for the escape of the gases as is usually done. Numerous analyses show that the method is capable of giving very satisfactory results.—*Zeitschrift für Analytische Chemie*, i, p. 2. W. G.

7. *On the determination of lithium as phosphate of lithia.*—Fresenius finds that lithia may be determined quantitatively in the form of phosphate according to the method proposed by Mayer. A weighed quantity of pure carbonate of lithia was dissolved in dilute sulphuric acid, the solution evaporated, the residue gently ignited, dissolved in a little water, and evaporated with phosphate of soda and enough caustic soda to give an alkaline reaction. The dry mass was gently heated with water, an equal volume of ammonia added, the whole digested at a gentle heat, filtered after standing twelve hours, and washed with a mixture composed of equal parts of water and ammonia. The filtrate and washings were again evaporated, and the residue treated as before, whereby a further portion of phosphate of lithia was obtained. This process must be repeated as long as weighable quantities of phosphate of lithia are observed. In this manner, very satisfactory results were obtained. It must however be remarked that the author employs in his calculations, the old equivalent of lithium 6·5 instead of 7, as determined by Mallet. The phosphate of lithia has the formula PO_5, 3LiO.—*Zeitschrift für Analytische Chemie*, i, p. 42. W. G.

II. GEOLOGY.

1. *Geology of Vermont.—Report on the Geology of Vermont; Descriptive, Theoretical, Economical and Scenographical;* by Edward Hitchcock, LL.D., Albert D. Hager, A.M., Edward Hitchcock, Jr., M.D., and Charles H. Hitchcock, A.M. Two volumes 4to, pp. 988, with 38 plates, including a Geological map of the State, a map of the Surface Geology, several smaller maps, two plates of Fossils, several plates of scenery, and numerous wood engravings. Printed by Messrs. Goddard, Claremont, N. H., 1861.*—These two handsome, well printed and well illustrated volumes, are devoted to the elucidation of the geological structure and economical resources of a highly interesting and difficult region. They constitute a very important work for which all will feel thankful, not only to the excellent geologists whose labors are recorded therein,

* Copies of this Report may be procured by writing to A. D. Hager, Proctorsville, Vt.

but also to the people of the state of Vermont to whose well known patriotic spirit and love of advancement, science is now indebted for a valuable and most welcome contribution.

The greater part of Vermont has long been disputed ground between the advocates of several rival theories. Upon one of these,—the Taconic System, much light has lately been thrown, by discoveries made within this State as our readers are well aware; but there are other great problems such as the geological age of the Green Mountains and of several of the formations lying in the neighborhood of this chain which still remain. The officers of the Vermont Survey have wisely left these open, while at the same time they have given their own views and also published at length the opinions of other investigators who have arrived at opposite or somewhat different conclusions.

As the formations in this region are arranged in long rudely parallel belts running north and south, the work of the survey was carried on by measuring fourteen sections across the whole state in an easterly and westerly direction. The sections are engraved and colored to correspond with the colors of the map. In the text copious details are given descriptive of the lithological characters and attitude of the strata crossed by these lines. The geological column consists of 25 formations, embracing Azoic, Silurian, Devonian and Pleistocene-tertiary beds. We have space to notice only some of the more important observations.

A great belt of gneiss enters from the south and runs north through the whole length of the state, (about 160 miles) dividing it into two portions of which the eastern is somewhat larger than the western. This gneiss constitutes the principal mass of the Green Mountain range, and being both metamorphic and unfossiliferous, there are no means of determining its age except by its physical relations, whether above, or below, or on the same horizon with some one or more of the neighboring deposits whose chronology can be established. It would appear that the first step in this process is to ascertain the general structure of the range, whether it be upon the whole anticlinal or synclinal. If it be anticlinal then the gneiss must be, or most probably is, the most ancient rock in the state, with the exception perhaps of the Laurentian, of which latter there is a small exposure near Whitehall, at the south extremity of Lake Champlain. But if the gneiss constitute a synclinal, then it may represent some one or more of the Silurian or Devonian formations in a metamorphic condition. It is evident that this great problem can be solved only by good field-work. Mere library work will not do. The chapter relating to this formation is written by C. H. Hitchcock, and he is of the opinion that upon the whole the Green Mountains have an anticlinal structure. As the range runs the whole length of the state all the sections cross it. Six out of the fourteen sections exhibit the anticlinal structure perfectly and without any modification. In four others the strata all dip towards the east and may represent either inverted anticlinals or anticlinals which have passed into a fault and exhibit only the eastern limb. The remaining four consist of several folds each, but do not upon the whole indicate a synclinal form. These all relate to the main range of the Green Mountains, but a short distance east of this principal chain there is a smaller belt which does not run the whole

length of the state. Six of the sections including one drawn across a portion of Massachusetts just south of the Vermont line, cross this smaller range of gneiss, and five out of the six are perfectly anticlinal; the sixth shows two folds, an anticlinal and a synclinal. As the localities where these sections may be examined are pointed out, and very full tables of the dip and strike of the strata at numerous localities are given, Mr. Hitchcock has undoubtedly advanced this great question to such a position as to throw the *onus probandi* on those who maintain the synclinal theory. All physical geologists will admit that good field-work can only be opposed by field-work, and therefore those who hold that there are no mountains on the face of the earth except such as have a synclinal structure, will hereafter in dealing with this particular chain, find it necessary to leave the easy chair and library and take some exercise in the open air and on the rough hill side.

Lying along the western base of the Green Mountains is a great formation of sandstone or quartz rock, the celebrated "granular quartz rock" which Dr. Emmons places at the base or low down in his Taconic series. In the opinion of the Vermont surveyors it rests upon the gneiss and is a more recent formation. It holds a few fossils and the determination of these is of great importance, because the evidence they afford will sooner or later not only decide conclusively the age of the rock in which they are found, but also most assuredly bear strongly upon the question of the age of the gneiss. In 1847 Prof. Hall published in the 1st vol. of the Palæontology of New York, one of the species as *Scolithus linearis* and identified the rock with the Potsdam sandstone. It had been previously, in 1841, referred to the same by Prof. H. D. Rogers, who also quoted this fossil in proof of his opinion. Some other fossils were afterwards found by Prof. Adams in this formation and referred to Prof. Hall. The following is his opinion as quoted in the Vermont Report, p. 356, from Foster and Whitney's Report upon the Land District of Lake Superior, 1851, p. 205. "I have recently received from Prof. Adams of Amherst, specimens of partially metamorphosed sandstone from Salisbury, Vermont, which he regards as the equivalent of the Potsdam sandstone. The specimens have all the characters of the purely quartzose variety of this rock, and contain fragments of crinoidal columns, and casts of an acephalous bivalve, similar to *Modiolopsis*. Such facts are highly interesting and promise important results for the future. Since however, no known fossils of the Potsdam sandstone occur with the rocks just mentioned, it requires a careful scrutiny to determine the age of the rock *in situ*."

Since that time a species of *Lingula* has also been discovered and was in 1860 placed in the hands of Mr. Hitchcock who referred it to Prof. Hall. The following is his opinion as quoted by Hitchcock, p. 500. "The Lingula though unsatisfactory, I regard as evidence of rocks of the age of the Clinton group of New York, or of Medina sandstone—a position reached by sandstones, a part of which we include in the Clinton and a part in the Medina sandstone."

It is to be regretted that these truly precious scraps of fossil evidence have not been carefully figured. A *Scolithus* very much like that of the Quartz Rock occurs in the Medina sandstone. No species of *Modiolop-*

sis has been found below the Chazy limestone in New York or Canada, although in the latter country one lamellibranchiate shell, a large *Conocardium* has been discovered in the Calciferous sandrock. The Vermont surveyors seem to have been to a great extent influenced by the fossil testimony as above interpreted in regarding the Quartz rock as of the age of the Medina sandstone.

The next formation of importance is the Eolian limestone, a vast deposit of crystalline rock 2000 feet in thickness, apparently overlying the Quartz rock. It is the Stockbridge limestone of the Taconic system and was first placed by H. D. Rogers in the horizon of the Lower Silurian limestone, including the Chazy, Black River and Trenton. It is found to contain several genera of fossils which have been referred to Prof. Hall for examination. With all deference we do not agree with him in his estimate of the weight of the evidence afforded by these remains. It appears that none of the species have been determined and that the conclusions were drawn from the range of the genera. *Euomphalus* both with round and angular whorls, the latter including *Helicotoma* (Salter) and *Ophileta* (Vanuxem) occurs abundantly in the Calciferous and Black River: and some of the species such as *H. planulata* and *Straparollus Circe* are very closely allied even specifically to Devonian and Carboniferous forms. No one can distinguish fragments of *Petraia* (*Streptelasma* Hall) from *Zaphrentis* without a knowledge of the age of the rock in which they are found. There is not the slightest generic difference between *Stromatopora* and *Stromatocerium* (Hall), the latter genus being abundant in the Lower Silurian limestones. *Stenopora* and *Ptilodictya* (*Chaetetes* and *Stictopora*) are also very prolific genera from the Chazy upwards. Very large round smooth crinoidal columns, such as those of *Cleiocrinus magnificus* occur in the Trenton. Wherever there are great deposits of Devonian or Carboniferous limestones, we are sure to find abundant remains of Brachiopoda of the genera *Producta*, *Chonetes*, *Spirifera*, &c., but no traces of these are reported as having been detected in the Eolian limestone. It would appear also that the fossils have been mostly found on the western side of the formation in Sudbury, Orwell, and Cornwall, in the neighborhood of the Red-sandrock which we now know to be about the age of the Potsdam. The evidence of the fossils therefore does not furnish any reasonable ground for placing this formation above the Lower Silurian. In the Report it is not positively placed in the Carboniferous system, the question being left open, but it is evident from the manner in which the fossils are quoted that that there is a very strong leaning in that direction. For this the surveyors are not responsible. The error is only a consequence of the old one, whose birth dates back to the publication of the 1st vol. of the Palæontology of New York.

The Eolian limestone appears to be developed upon a magnificent scale, and constitutes the principal portion of several ranges of mountains in the southern half of the State. Some of these, such as Mt. Eolus, exhibit a very perfect synclinal structure. They constitute however no part of the Green mountains, but independent ranges lying near and parallel thereto. The Quartz Rock forms a belt between the limestone and the gneiss. The gneiss appears to be the oldest rock; the

quartz rock the next younger and the limestone the most recent of the three.

We have noticed particularly the above three formations because the correct determination of their age must be made a starting point for future investigations in the large azoic tract lying east of the Green Mountains. In this latter region there is a narrow belt of Devonian limestone about one mile in width and 20 or 30 in length. All the rest appears to consist of unfossiliferous rocks of undetermined age, although their geographical distribution and general relations to each other are well made out and clearly defined on the excellent map and sections of the survey.

The western part of the State lying along Lake Champlain consists of the Lower Silurian and Primordial rocks, the most interesting being the Red-sandrock and Georgia slates so frequently noticed in our pages. There are also two formations of slaty rocks, the Talcoid schist and Talcose conglomerate, west of the Green Mountains, which we have not space to notice.

The first volume of this report opens with a preliminary chapter of 52 pages treating of the general principles of geology, metamorphism and classification of rocks and fossils. The remainder to page 555 is divided into three parts; the first relating to the recent and Tertiary deposits, the phenomena of drift and surface geology. The second, by E. Hitchcock, Senior, is devoted to the Palæozoic, and the third, by C. H. Hitchcock, to the Azoic rocks. The second volume contains parts 4 to 10 inclusive. The 4th part treats of the unstratified rocks; the 5th notes on the geological sections; the 6th, by E. Hitchcock, Jr., localities of minerals; the 7th, Chemical Analyses, by C. H. Hitchcock; the 8th contains two local reports; one relating to the geology of northern Vermont, by the Rev. S. R. Hall, and another on the geology of Plymouth, by A. D. Hager. The 9th, by A. D. Hager is an excellent and very full report on the economical geology of the State. The 10th, also by Hager, gives an interesting account of the Physical Geography, illustrated by 19 lithographic plates of the scenery for which Vermont is famous. The map is remarkable for the clearness with which the different formations are defined, and the colors are numbered to correspond with the numbers of the geological column. It is to be hoped that some such method as this last will be adopted for all maps. For the want of it, some elaborate works of this kind, such as the splendid map of Pennsylvania, can be understood only by much disheartening labor. Upon the whole we look upon this Report as one of the best that has been published on this continent. E. B.

Montreal, 18th March, 1862.

2. *On the date of the recently published Report of the Superintendent of the Geological Survey of Wisconsin, exhibiting the Progress of the work Jan.* 1, 1861. Madison, Wis.: E. A. Calkins & Co., State Printers. pp. 52, 8vo. By E. Billings.—This Report contains descriptions of about 60 species of fossils from the Silurian rocks of Wisconsin, by Prof. Hall, Superintendent of the Survey. A copy of it was sent to Prof. Dana by Mr. Hall, I understand, Dec. 27, 1861, but it was not received at the office of the Geological Survey of Canada until March 12th. Dr. Dawson noticed the first sheet in the December number of the Canadian Naturalist, which was published on the 1st day of Feb.,

1862. On one of the two copies received here is written (in a hand writing which I do not recognize) the words "Published Nov. 1861." The sheet noticed by Dr. Dawson was sent him by Prof. Hall in November or December. It is quite clear therefore that this publication is antedated at least 11 or 12 months. In November, 1861, I published a description of the genus *Obolella*, and pointed out the characters of a species from the Potsdam sandstone of Wisconsin. My paper was published on the 21st of Nov., and a copy sent to Prof. Hall on the 22d. On page 24 of his Report Prof. Hall describes the same species under the name of *Lingula polita*. His description of the interior of the shell is, in substance, the same as mine, and he expresses the opinion that the species is neither an *Obolus* nor a *Lingula*. Any person in possession of the two papers would come to the conclusion that I had taken the hint for the institution of the genus *Obolella* from Prof. Hall, as his report is dated nearly eleven months before mine. I take this opportunity of stating that I never saw his report nor had the least idea of its existence until the month of February, 1862, more than two months after my paper was published, and fourteen months after the date which he has placed on his title page. It is extremely disagreeable for me to write this, but any one can see that I am forced to do it or leave myself open to the charge of plagiarism, which does not attach to me in this case certainly. It is fortunate for American science that this practice is confined within an extremely small circle, otherwise many of the costly works published by the enlightened policy of many of the state governments of the United States would lose much of their authority. Whenever any of those dates prove to be erroneous I shall not hesitate to state it, as I have a perfect right to do, in the most public manner. E. B.

Montreal, March 24th, 1862.

3. *Correction of the Article on the Red Sandrock in this vol., p.* 100; by E. Billings.—In my paper on the Red Sandrock of Vermont, (this vol. p. 100) I have inadvertently said that Barrande first determined the age of the Georgia slates. My attention has been since called to this passage by one of the parties interested, who says that it seems to exclude Dr. Emmons from the discovery. Such an idea never occurred to me while writing the article. I should have said that with the exception of Dr. Emmons, Barrande was the first. I was aware of Dr. Emmon's opinion four or five years ago. Col. E. Jewett of the Geological Museum of the State of New York, wrote me several letters in 1857 and 1858 on the subject, and sent me specimens of the trilobites for examination. He strongly urged upon me the importance of investigating the matter. As we had not at that time any such fossils in Canada, and as I wished to keep aloof from the Taconic question, I did nothing further than to express my coincidence with them in their previously entertained views that the fossils had a true primordial aspect. In the winter of 1860 I brought them under Barrande's notice as constituting with some others a primordial colony in the Hudson River group. I said nothing to him about the Taconic question, and I included in the supposed colony three species of *Triarthus*. Barrande immediately replied that he did not think it a colony. While his letter was on the way we discovered the

Quebec trilobites, and before my letter communicating this new evidence reached him he had written to Prof. Bronn the letter which has already appeared in these pages, (see xxxi, p. 212). The Quebec fossils removed all doubt from my mind at once. But it was not until I had procured the opinions of Barrande, De Verneuil, Angelin, (the two latter through Barrande) Salter, Shumard and Safford, that the great weight of the opposing American authority could be removed. No one can claim, or professes to claim priority over Dr. Emmons, whose reputation as the originator of the idea of a pre-silurian fauna in America is world-wide.

In the table of fossils, p. 104, the species, *P. congregatus* belongs to the Vermont column and not to the other. Also the word *Koturgina* should be *Kutorgina*.

4. *Observations upon the rocks of the Mississippi Valley which have been referred to the Chemung Group of New York, together with descriptions of New Species of fossils from the same horizon at Burlington, Iowa;* by C. A. WHITE and R. P. WHITFIELD. [Proceed. Boston Soc. Nat. History, vol. viii, p. 289 to 304, inclusive.]

This paper, or at least that portion of it received at this date, (March 13th,) contains descriptions of twenty-seven new species of fossils, which are referred to the following genera, viz:—*Orthis*, *Streptorhynchus*, *Spirifer*, *Retzia*, *Rhynchonella*, *Pentamerus*, *Aviculopecten*, *Mytilus*, *Orthonota*, *Nucula*, *Leda*, *Macrodon*, *Conocardium*, *Cypricardia?*, *Cypricardella*, *Edmondia*, *Euomphalus*, *Platyceras*, *Pleurotomaria*, *Murchisonia*, *Porcellia* and *Bellerophon*.

These fossils were all collected at and near Burlington, Iowa, from a series of more or less arenaceous strata holding a position immediately beneath that member of the Carboniferous System in the west usually known as the Burlington limestone. In regard to the exact position in the Geological column, to which these lower beds belong, some difference of opinion exists. Doctors Owen and Norwood, and Mr. Pratten, included them in the Sub-Carboniferous series, as did Dr. Shumard and Prof. Yandell, Mr. DeVerneuil and others, equivalent strata at other localities in the west. Prof. Hall, however, maintains that these deposits represent the Chemung Group of New York, though as will be seen farther on, he not long since referred an equivalent stratum at Rockford, Indiana, to the Marcellus Shale, holding a position far beneath the Chemung, at the base of the Hamilton Group. Prof. Swallow and his assistants in the Geological Survey of Missouri, after identifying in the representative strata of that state, several of the same fossils known to occur in beds referred by Prof. Hall to the Chemung at other localities in the west, also placed them on a parallel with that rock.

More recently, Meek and Worthen, while investigating the fossils contained in the collections of the Geological Survey of Illinois, failing to find, after careful comparisons of extensive collections from these beds at numerous localities, a single species they could identify with any known Chemung form,—and finding them not only generally presenting close affinities to Carboniferous types both of this country and Europe, but in many cases in all respects undistinguishable from forms known to occur in well marked Carboniferous beds above, were naturally led to doubt the propriety of referring them to the Chemung epoch. These doubts were

strengthened by a knowledge of the intimate relations existing between these beds and the Burlington Limestone, (acknowledged Carboniferous) wherever they occur at the same locality,—the two rocks being always conformable, and never separated by any intervening beds,—while the Chemung Group is known to be separated at places in New York, from the proper horizon of the Subcarboniferous, by a great thickness of Old Red Sandstone, containing the remains of a peculiar fauna of its own.

The views of Meek and Worthen on this subject were given more in detail in a paper published in the September number of this Journal, commencing on page 167.* By reference to this paper, it will be seen, however, that the principal objects its authors had in view, were to show:

1st, That the Rockford Goniatite bed, which Prof. Hall had in a paper published in the Thirteenth Annual report of the Regents of the University of New York, referred to the horizon of the Marcellus Shale of the New York Series, is much more recent than that rock, and in fact an equivalent of the beds at Burlington, Iowa, which he had placed on a parallel with the Chemung Group.

2d, That the Black Slate of the west, which the same author had also regarded as belonging to the horizon of the Marcellus Shale, (his impression at that time being that the Goniatite bed was an intercalated layer in the Black Slate) instead of holding a position at the *base* of the Hamilton Group, comes in *above* all the Hamilton Group beds in Illinois—and from this fact, as well as from the affinities of the very few fossils hitherto found in it, more probably represents the Genesee Slate of the New York Series, as suggested by Prof. Yandell and Dr. Shumard, as well as by Mr. DeVerneuil.

3d, That the beds at Burlington, Iowa, referred by Prof. Hall in the Iowa Report to the Chemung, and their equivalents at Rockford, Indiana, and in Missouri and Illinois, ought not to be regarded as strictly contemporaneous with the Chemung Group of New York, but belong to a more recent period; though they did not say they regarded it as demonstrated that these beds belong to the Carboniferous System.†

Some time during the same month that the paper above alluded to was published in this Journal, Prof. Hall issued a continuation of his paper in the Report of the Regents, containing a supplementary note in which he states that in consequence of having discovered amongst his specimens from a rock in Ohio regarded by him as representing the Chemung Group of New York, a Goniatite identical with one of the Rockford species, he has been led to modify his opinion in regard to the age of the Rockford Goniatite bed, so as to carry it up to the horizon of the Chemung. He also states that this discovery leads him to think "there is room to doubt" in regard to the relative position of the Hamilton Group and the Black Slate of the west, and whether this slate, "may be

* Remarks on the age of the Goniatite Limestone at Rockford, Indiana, and its relations to the "Black Slate" of the Western States, and to some of the succeeding rocks above the latter; by F. B. Meek and A. H. Worthen.

† They likewise admitted that there may be some representation of the Chemung Group below the horizon of the Chouteau Limestone of Prof. Swallow, and its equivalents at Burlington, Iowa, and Rockford, Indiana, but denied that this had yet been clearly established.

regarded as a continuation of the Marcellus Shale, or the Genesee Slate of New York."

As the authors of the paper under review, raise no objection to the position taken by Meek and Worthen in regard to the Black Slate of the West representing the Genesee Slate instead of the Marcellus Shale, as had been maintained; and admit that the Rockford Goniatite bed does not, as had been asserted, represent a certain bed in the Marcellus Shale of New York, but belongs to the same horizon as the beds that had been referred to the Chemung at Burlington, Iowa,—it may, we think, be taken for granted that there is now no difference of opinion on any of the points, excepting in regard to the Rockford bed and its equivalent strata in Missouri, and at Burlington, Iowa, being newer than the Chemung.

In regard to this latter question, the authors of the paper under review, still maintain that these strata represent the Chemung group. They do not claim, however, to have identified a single Chemung species amongst the fossils of these beds, but on the contrary not only admit that they are, so far as known, all distinct from the species found in the Chemung of New York, but that they present strongly marked carboniferous affinities. One of the same authors also, not long since, showed in a paper published in the Boston Proceedings, that at Burlington, a number of the characteristic fossils of these strata pass up into the well marked Carboniferous beds above.

The grounds then upon which the identity of these rocks with the Chemung in New York, is maintained, is, that the *Goniatite* mentioned by Prof. Hall, and a few other fossils, the names of which are not given, from a bed in northwestern Ohio, regarded as a continuation of the Chemung, are considered identical with species in the rocks referred to that horizon west of the Cincinnati axis. At the same time it is admitted that the group of fossils found in the rock referred to in Ohio, also presents a strange and unaccountable similarity to Carboniferous types. The explanation of this anomaly given, is, that "we find in tracing these rocks [the Chemung] westward from New York, a tendency of the fauna to assume a decided Carboniferous character." And it is admitted that, "in some parts of northwestern Ohio, this character is as decided as that of the fauna of the Burlington limestone, &c." Hence the startling conclusion is arrived at, and stated as a general principle, that "if it is our desire, as far as possible to recognize formations over wide areas, that are already well known and named, it appears evident that we must ultimately be confined to the use of generic values, and relative position;" thus completely ignoring the use of specific affinities in the identification of strata at distantly separated localities, even in the same zones of latitude.*

If these conclusions are sound,—that is, if in tracing the same formation westward, which is in eastern New York characterized by an

* We are aware Prof. Agassiz has shown that the fossils of synchronous deposits in different zones of latitude, sometimes present much more marked differences than geologists have generally supposed. Yet it will scarcely be maintained, we think, that the striking differences observed between the fossils of the Chemung group in southern New York, and those of some of the beds referred to that epoch in northwestern Ohio, and at Burlington, Iowa, can be due to differences of climatic, or other physical conditions, dependent upon latitude.

acknowledged Devonian fauna, and holds a position beneath fifteen hundred to two thousand feet of other Devonian strata, we find it as we go westward from New York, assuming a more and more Carboniferous character, so that in northwestern Ohio, its fossils become as decidedly Carboniferous as those of the Burlington limestone; and that again in tracing it farther westward to the shores of the Mississippi, we find it not only presenting similar Carboniferous affinities, but so intimately connected by the mingling of its fossils with those of well marked and undoubted Carboniferous beds above, that no very sharp line of separation can be drawn between them,—we may reasonably infer that if the same beds were exposed midway between the Mississippi and the Rocky Mountains we should find them containing the remains of an Upper Carboniferous fauna, and in seeking for them at the Rocky Mountains, we should not look for Devonian, but Permian or Triassic fossils.

Surely before geologists admit such conclusions as these, striking as they do at the very foundation of geological science, they have a right either to question the identity of the few fossils mentioned from northwestern Ohio, with species occurring in the rocks referred to the Chemung, west of the Cincinnati axis, or to doubt that the particular beds in which they occur in Ohio, are exactly synchronous with the Chemung of eastern New York. Otherwise we may cast Palæontology to the winds, so far as the identification of strata is concerned.

But it is asserted with much confidence, that such are the facts, at least in tracing the Chemung westward from eastern New York to Iowa. It will, however, be remembered that it was just as confidently asserted recently, and that too, as was supposed, upon palæontological grounds, that the Rockford Goniatite bed and the Black Slate of the west, belong to the horizon of the Marcellus Shale; and yet it is now admitted that the first must be carried up at least as high as the Chemung, and that the latter *may* represent the Genesee Slate instead of the Marcellus Shale. Again it is not very long since it was maintained with quite as much confidence that certain rocks in Vermont containing Primordial types of *Trilobites*, belonged to the horizon of the Hudson River Group; yet, thanks to the profound palæontological skill of Mr. Billings, of Canada, and Prof. Barrande, of Bohemia, it is now known that they really belong far down at the base of the Silurian Series.

5. Geinitz: *Dyas, oder die Zechstein-Formation und das Rothliegende*, von Dr. Hanns Bruno-Geinitz, Leipzig, 1861—4°, pp. 130, 23 plates. —This excellent memoir on the group of rocks called Permian by Murchison, has reached us from the author. We propose in a following number to notice some of the conclusions, and especially to present a comparison of the characteristic European and American fossils.

At this moment we will only add a few remarks on the name Dyas. It was first proposed in 1859 by Marcou, and signifies that the formation consists of two parts,—the marine beds of the Zechstein (Magnesian limestone) and the upper portion of the Roth-liegende (Red layers, Gres bigarré). These are conformable and are overlaid by the Trias.

It will be remembered that in 1859 Sir R. I. Murchison published in

this Journal (xxviii, 256), a notice of Marcou's Memoir entitled "Dyas et Trias," &c. The same author now reviews the arguments then used, and enforces it by new illustrations in a paper entitled, 'On the inapplicability of the New Term Dyas to the Permian group of rocks as proposed by Dr. Geinitz.' He aims to show that the term Dyas can be used only in open violation of all well established palæontological values—that it rests on certain lithological distinctions not essential or constant and is more objectionable than the kindred term 'Trias.'

He says "In borrowing the term 'Dyas' from Marcou, Dr. Geinitz shows, however, that that author had been entirely mistaken in grouping the deposits so named with the Trias or the Lower Secondary Rocks, and necessarily agrees with me in considering the group to be of Palæozoic age." After showing the reasons which in 1840–41 led him and his associates De Verneuil and Count Keyserling to propose the term "Permian" for the great group of sandstones, marls, pebble beds, copper ores, gypsums, &c., which have since been accepted under this designation, he adds:

"The chief reason assigned by Geinitz for the substitution of the word 'Dyas' is, that in parts of Germany the group is divided into two essential parts only—the Roth-liegende below, and the Zechstein above, the latter being separated abruptly from all overlying deposits.

"Now, not doubting that this arrangement suits certain localities, I affirm that it is entirely inapplicable to many other tracts. For, in other regions besides Russia, the series of sands, pebbles, marls, and gypseous, cupriferous, and calcareous deposits form but one great series. In short, the Permian deposits are for ever varying. Thus in one district they constitute a *Monas* only, in others a *Dyas*, in a third a *Trias*, and in a fourth a *Tetras*.* * * * *

"On my own part, I long ago expressed my dislike to the term Trias; for, in common with many practical geologists who had surveyed various countries where that group abounds, I knew that in numerous tracts the deposits of this age are frequently not divisible into three parts. In Central Germany, where the Muschelkalk forms the central band of the group, with its subjacent Bunter Sandstein and the overlying Keuper, the name was indeed well used by Alberti, who first proposed it; but when the same group is followed to the west, the lower of the three divisions, even in Germany, is seen to expand into two bands, which are laid down as separate deposits on geological maps of Ludwig and other authors. In these countries, therefore, the Trias of Alberti's tract has already become a Tetras. In Britain it parts entirely with its central or calcareous band, the Muschelkalk, and is no longer a Trias; but, consisting simply of Bunter Sandstein below, and Keuper above, it is therefore a Dyas; though here again the Geological Surveyors have divided the group into four and even into five parts, as the group is laid down upon the map—No. 62, 'Geographical Survey of Great Britain.'

"Respecting as I do the labors of the German geologists who have distinguished themselves in describing the order of the strata and the fossil contents of the group under consideration, I claim no other merit

* See 'Siluria,' 2d edit., 1859, and 'Russia in Europe and the Ural Mountains,' 1845.

on this point for my colleagues de Verneuil and von Keyserling, and myself, than that of having propounded twenty years ago the name of 'Permian' to embrace in one natural series those subformations for which no collective name had been adopted. Independently, therefore, of the reasons above given, which show the inapplicability of the word 'Dyas,' I trust that, in accordance with those rules of priority which guide naturalists, the word 'Permian' will be maintained in geological classification."

However the term Dyas, adopted by Dr. Geinitz as the title of his memoir, may be open to criticism, it is a pleasure to add that no recent memoir in geology does its author more credit or is more valuable in itself. We shall revert to it again with pleasure, as suggested above.

III. BOTANY AND ZOOLOGY.

1. *Botanical Necrology for* 1861.—The list includes the following names:—

Ferdinand Deppe, who in connexion with Schiede collected plants in Mexico, and to whom Chamisso and Schlechtendal dedicated the Rubiaceous genus *Deppea*.

A. E. Fürnrohr, the editor since the year 1843 of the "Flora oder Botanische Zeitung," of the well-known Botanical Society of Ratisbon.

Henckel von Donnersmarck, of Prussia, who must have reached a venerable age, as he published an Index to Willdenow's Species Plantarum in the year 1803, and other of his publications (which were small) are half a century old.

Rev. John S. Henslow, Professor of Botany in Cambridge University; born at Rochester in 1796; died at the rectory of Hitcham, Suffolk, May 16, 1861. Professor Henslow wrote the treatise on Botany forming the 75th volume of Lardner's Cabinet Cyclopædia; it was published in 1835, and did good service in its day. We are indebted to him, also, for an excellent Dictionary of Botanical Terms, recently published (without date) by Groombridge & Sons. Although the part which Prof. Henslow played in the direct advancement of the science was comparatively unimportant, his influence in botanical education, both at the University and in elementary schools, was very great, and his death left a void in England which is felt to be irreparable. Appreciative notices of his life and character were published in the Athenæum and in the Gardener's Chronicle.

Prince Salm-Dyck (*Joseph v. Salm-Rifferscheid-Dyck*) died at Nizza, his seat near the Rhine, in the 88th year of his age. His princely conservatories were devoted during a long series of years to the cultivation of succulent plants, which he assiduously collected from every part of the world, and illustrated in a series of monographs and catalogues, beginning with the genus *Aloë*, in 1817, and ending with the *Cacteæ in Horto Dyckensi*, in 1845. The good old prince—one of the mediatized at the dissolution of the German empire in 1806,—lacked little of being a century plant himself.

Prof. M. Tenore, the author of the *Flora Neapolitana*, and for 50 years director of the Naples Botanic Garden, the Nestor of Italian botan-

ists, died on the 22d of July last, at the age of 81 years. His earliest botanical publication appeared in the second year of the present century.

Jules M. C. Marquis de Tristan, of Orleans, died on the 24th of January, 1861, having almost completed his 85th year. He was the author of several botanical papers of interest, as well as of some metaphysical works, and even so late as the year 1851 he read a botanical communication to the Scientific Congress at its meeting at Orleans. It was for him that Brown in 1812 named the Myrtaceous genus *Tristania*, —a name which (the etymology being unexplained by its author) Sir James E. Smith, in the Encyclopædia Britannica, ingeniously attempted to derive from the Greek.

Prof. G. W. F. Wenderoth, of Marburg, died on the 5th of June last, at the age of 87. He was a pupil of Mœnch and his successor at the Marburg Botanic Garden, &c., and the author of numerous botanical works.

While preparing the above notices the sad intelligence is received of the death of three very distinguished botanists of Holland, at the commencement of the current year, viz:

Dr. R. B. Van den Bosch, of Goes, the acute monographer of *Hymenophyllaceæ*, and editor, in part, of the Bryologia Javanica after the decease successively of its original authors, Dozy and Molkenboer. (He died on the 18th of January, at the age of 51.)

Prof. Wm. H. De Vriese, of the University of Leyden, a most active and estimable botanist, author of many important works and memoirs. He died on the 23d of January last, at the early age of 55 years, only ten months after his return from a laborious and successful mission, under the appointment of the Dutch Government, to the Dutch East Indian possessions, to investigate their botanical resources and culture.

Dr. Charles Louis Blume, an older and still more renowned botanist, the curator of the Herbarium of the Royal Museum at Leyden, as we learn from the same source (Gard. Chronicle of Feb. 8), died a few days later than Dr. DeVriese, viz., about the first of February. Dr. Blume's earliest publications, issued at Batavia, while he was in charge of the Colonial botanic gardens of Java, bear the dates of 1823 to 1826. His later works, several of them of a magnificent character, come down to a very recent date. (He died on the 3d of February, in the 66th year of his age.)

Dr. Edwin James died at Rock Spring, near Burlington, Illinois, on the 28th of October, 1861, at the age of 64 years. As the earliest botanical explorer of an alpine region, in which Dr. Parry has recently much interested the readers of this Journal, it is with peculiar propriety that the following biographical notice of this pioneer of Rocky Mountain botany is furnished by Dr. Parry. A. G.

2. *Dr. Edwin James*, who is best known among scientific men in this country as the Botanist and Historian of Long's Expedition to the Rocky Mountains, in 1820, was born in Weybridge, Addison county, Vermont, on the 27th day of August, 1797. His father, Deacon Daniel James, was a native of Rhode Island, and removed to Vermont, about the commencement of the revolutionary war. Edwin, the subject of this sketch, was the youngest of ten sons, three of whom became physicians. His early studies were conducted at home, in the manner usual

at that period; the summer months being devoted to the labors of the farm, and the winter spent at the district school. From a youth he was noted for activity, application, and industry. He pursued his academic and collegiate course at Middlebury, Vt., where he was graduated in 1816. Subsequently he engaged in the study of medicine, for three years, under an elder brother, Dr. Daniel James, in Albany, New York. While pursuing his medical studies, he was particularly interested in the Natural Sciences, then taught by Prof. Eaton, under the distinguished patronage of the late Stephen Van Rensselaer.

In the spring of 1820, Dr. James was attached to the Exploring Expedition of Col. Long, as botanist and geologist, taking the place of Dr. Baldwin, who accompanied this expedition on the previous season as far as Franklin, on the Missouri River, where he terminated his labors and his life.

Dr. James was recommended to this situation, by Hon. Smith Thompson, Sec'ty. of the Navy, Capt. Leconte, and by Dr. John Torrey, whose subsequent labors as the descriptive botanist of Dr. James' collections, has intimately associated his name with this pioneer Expedition. The connection of Dr. James with the expedition, lasted till its close, being engaged in active exploration, during the season of 1820, from May to November.

The efficient labors of Dr. James, in this arduous trip, may be readily inferred from the published scientific results. Interesting additions were made to our knowledge of the botany of the great plains, at that time but imperfectly known. The elevated peaks, forming the outliers of the Rocky Mountain range, rivaling in altitude the snowy summits of Mt. Blanc, revealed a flora of exceeding richness, and attracted the attention of botanists both in this country and in Europe. We can easily imagine the enthusiastic ardor with which the young naturalist, treading for the first time these alpine heights, gathered up its floral treasures, and scaled the snowy peak, which ought properly to bear his name. It is still unexplained why the recommendation of Col. Long, applying to this mountain the name of *James' Peak*, has not been adopted, by modern geographers. Amid the great number of elevated landmarks, of this region, some other peak fully as appropriate, might have been selected to bear the name of the enterprising *Pike*.

On returning from this expedition, the attention of Dr. James was occupied, for about two years, in compiling the results of the same, which were published, both in this country and in Europe, in 1823. The work elicited no little interest, and is now a valued fund of historical and scientific facts.

On the completion of this work, Dr. James was for six or seven years connected with the United States Army, as Surgeon, serving in that capacity at several of the extreme frontier posts. During this period, aside from his professional duties, he was occupied with the study of the native Indian dialects, and prepared a translation of the New Testament, in the Ojibwe language; subsequently published, in 1833. He was also the author of a life of John Tanner, a strange frontier character, who was stolen when a child from his home on the Ohio River by Indians, among whom he was brought up, developing in his future eventful his-

tory a strange mixture of the different traits pertaining to his early life, and savage education.

On the reorganization of the medical department of the U. S. Army, in 1830, Dr. James resigned his commission, and returned to Albany, N. Y., where for a short time he was associate editor of a temperance journal, conducted by E. C. Delavan, Esq.

After leaving this, he concluded to make his home in the far west, and in 1836 he settled in the vicinity of Burlington, Iowa, where he spent the remainder of his life, devoted mainly to agricultural pursuits.

It was at about this time that some peculiar traits, which distinguished Dr. James as a *strange* man, became more conspicuous. His mode of life, his opinions, and his views on moral and religious questions generally, were inclined to ultraism. Failing to find earnest sympathy, among those with whom he was thrown in contact, he gradually assumed the habits of a recluse. Indifferent always to public opinion, he marked out, and pursued his own course, without regard to the views of others. Strictly honorable in all his dealings with mankind, and naturally kind-hearted, he did not care to waste his sympathy where it would not be appreciated. With him to espouse a cause, was to carry it to the farthest possible extreme, often erroneous, and it is to be feared at times positively wrong. In full justice however to his many amiable traits, it must be admitted that his errors were on the side of goodness, and in all his waywardness, he never forfeited his self-respect, or the attachment of those who had known him in early life. In his personal appearance, Dr. James was tall, erect, with a benevolent expression of countenance, and a piercing black eye.

"On the 25th of October, 1861, he fell from a load of wood, the team descending a small pitch of ground, near his house, and both wheels passed over his chest. He at once said that he was a dead man. He lingered, much of the time in great pain, until the morning of October 28th, when he expired at the age of 64 years." C. C. P.

3. *DeCandolle's Prodromus:* Pars xv, Sect. posterior: fasc. I. Jan., 1862, pp. 188.—This includes the genus *Euphorbia*, elaborated by the indefatigable Boissier, issued in advance of the rest of the *Euphorbiaceæ*, which are undertaken by J. Müller, also of Geneva. Boissier, who is a keen observer, admits about 700 species of *Euphorbia*. That is, he describes 963 species chiefly from his own knowledge, and adds seven which are imperfectly known and not recognized by him, not to speak of 23 wholly obscure ones in the books. So that the Linnæan genus *Euphorbia* (which Boissier has the good judgment to retain entire) rivals *Carex*, *Solanum*, and *Senecio* in vastness. Dr. Engelmann, who has specially studied our species, and to whom Boissier acknowledges his particular obligations, should offer comments, if any be necessary, upon the present arrangement, as respects the North American species. A. G.

4. *Illustrations of the Genus Carex;* by Francis Boott, M.D. Part III, tab. 311–411. London, W. Pamplin. 1862.—The first of these magnificent folios was issued in the year 1858; the second in 1860; the third is now, thanks to the extreme liberality of the author, in the hands of many of the principal botanists of this country. Our former

notices have explained the nature and extent of this great monograph. In this, as in the preceding volumes, Dr. Boott has favored the land of his birth and early years—and which would fain still claim him as her own,—by devoting half of his plates to the illustration of North American species. And with such generous profusion, such as only a love of Carices for their own sake could inspire,—lavishing four folio plates upon such a common and homely species as *C. vulpinoidea*, two upon the equally vulgar *C. stipata*, three upon *C. cephaloidea*, two upon *C. Muhlenbergii*, &c. The latter and their allies, however, as well as the group of *C. straminea*, are critical subjects, which the fullest elucidation will render none too clear. As Carices are still favorites with our botanists, we will enumerate the North American species which are illustrated in the present volume.

C. riparia, Curtis. To this European species, Dr. Boott restores our *C. lacustris*, and he figures North American specimens. It extends into South America, as far as to Chili and Montevideo.

C. alpina, Sw., including *C. Vahlii*, an arctic-alpine species.

C. atrata, L., including *C. nigra*, also arctic-alpine.

C. scoparia, Schk.; with its var. *minor*, from Arctic America and New Hampshire.

C. lagopodioides, Schk., distinct from the next.

C. cristata, Schweinitz, including *C. mirabilis*, Dewey,—filling three plates.

C. fœnea, Willd., also from New Granada,—filling three plates.

C. alata, Torr., figured from New York as well as Florida and Texan specimens.

C. adusta, Boott, including *C. argyrantha*, Tuckerman, and, as a northern variety, *C. pratensis*, Drejer,—illustrated by five plates! Carey's *C. adusta*, in Gray's Manual, Dr. Boott figures as a variety of *C. fœnea*.

C. straminea, Schk., with its varieties *tenera*, *aperta*, *festucacea*, *Crawei*, and *Meadii*,—six plates. The whole group, thus revised, will probably now be better understood than before.

C. stipata, Muhl., which comes also from Japan.

C. conjuncta, Boott, a new species, founded on the plant referred by Carey, in Gray's Manual, to *C. vulpina*, a plant of the Western States.

C. sparganioides, Muhl., with its variety *minor*.

C. cephaloidea, Dewey, at least in part, excluding the description in Wood's Botany.

C. cephalophora, Muhl., with *C. Leavenworthii*, Dewey, as a variety.

C. Muhlenbergii, Schk., and its variety *enervis*.

C. vulpinoidea, Michx., including *C. setacea* and *C. scabrior* of Dewey, "founded on immature specimens," *more suo*.

C. disticha, Huds., to which belongs *C. Sartwellii*, Dewey.

C. Gayana, Desv., a Chilian species, collected in New Mexico by Fendler (No. 881), and in the Rocky Mountains by Bourgeau.

It will be seen that this volume, illustrating some of our most troublesome species, will be particularly useful to North American botanists, who, with lively gratitude for what has been so generously done for them, indulge the earnest hope that the author's zeal and strength may enable him, *Deo favente*, to crown the whole with volume four. A. G.

5. *Thwaites, Enumeratio Plantarum Zeylaniæ, an Enumeration of Ceylon Plants, &c.*, Part III.—Although it has just reached us, this part bears the date of 1860. It comprises the *Monopetalæ*, excepting the *Rubiaceæ*, &c., which were in the second part. When finished we shall have a reliable and very convenient conspectus of the flora of Ceylon in a compact form. A. G.

6. *Annals of the Botanical Society of Canada:* Part III. From April, 1861, to February, 1862.—Contains the record of the general proceedings of this Society, as well as abstracts of some papers read, while others are printed *in extenso*. The contents are quite miscellaneous, many of the papers relating to culture or other practical subjects; and there are some local catalogues, &c. The society is evidently popular and flourishing, and is finding its way to its proper work. A. G.

7. *Bonapartea juncea* (Paxton's Bot. Dict.).—This rare and curious plant blossomed the last season at the Mount Hope Nurseries in this city. It belongs to the Pine Apple tribe, and was discovered in Peru, in 1800. It is one of the Bromeliaceæ, and was named, as above, in honor of Napoleon I. It has a large globose head just above the ground, covered with large scales closely compacted, from each of which arises a long, rush-like, four-sided and arching leaf more than a foot in length, presenting a very beautiful appearance. The intelligent proprietors of these nurseries, Messrs. Ellwanger & Barry, have reared this greenhouse plant for twenty-two years, but they do not know how old it was when purchased of Mr. Prince of Long Island, though then evidently not very young. Such had been its appearance for many years.

About the 10th of last September, from the summit of the globular head shot out a round tapering stem, near two inches in diameter, bearing small scales two to four inches apart and terminating in a small cuspidate point three inches long. The stem or scape grew rapidly, three or four inches a day, and once six inches, to the length of fifteen feet in less than sixty days. Three feet from the globular head there put forth a pair of flower-buds at each scale to the summit or through twelve feet, which soon began to blossom from the lowest in succession to the top. The flowers were yellowish or greenish-yellow, not striking, except for their great number. The pistil, six stamens, with versatile anthers, and the floral envelops of three inner and three outer parts, all stood on the ovary. The flowers did not come forth rapidly, so that the upper foot of them did not appear till February. On the lower part, the flowers rapidly decayed and fell off with the seed-vessel for six feet; but, on the plant being abundantly watered at the root, the flowers ceased to fall, and had the appearance of maturing some seeds. The plant was growing in an equably heated greenhouse. In the middle of March the plant was still maturing its seeds, though it is still doubtful whether any of them will be ripened, while it is certain that months must first intervene. There is no record of the flowering of this plant in the United States. An English nurseryman says he saw this species in flower in the garden of the Duke of Devonshire many years since. These few facts may be worthy of record in this Journal. C. D.

Rochester, March 25th, 1862.

8. *Acclimation encouraged in Australia.*—We have more than once had occasion to refer to the remarkable and well directed scientific activity which so honorably distinguishes the Australian colonies, and especially the colony of Victoria. To the Government Botanic Garden at Melbourne a Zoological Garden has been attached, and an Acclimatisation Society is coöperating in a practical direction. While Europe and America are making acquaintance with many a queer Australian beast or bird, or apparent combination of the two—like the *Ornithorhynchus*, our enterprising friends and neighbors at the antipodes are striving to stock their glades and streams with fish, flesh, and fowl from all lands, adapted to their fine climate, and subservient to use or ornament. Already, we believe, "the voice of the turtle is heard in their land," and the lark has become a denizen,—not to mention fowl of various kinds, of economical importance. As there is regular communication between New York and Boston and Melbourne, it may be well to publish here the following advertisement.

"*The Acclimatisation Society of Victoria, Australia*, are willing to make purchases of such useful or ornamental birds, animals, and fish landed in Melbourne, as may meet the requirements of the Society.

W. H. Archer, *Hon. Sec.*

"*The Argus Gold Prize Cup.*—The Argus gold prize cup, of the value of one hundred pounds, for the year 1861, will be given to any one (unconnected with *The Argus* or *Yeoman* newspapers) who, within the year ending 31st October, 1862, shall introduce into the colony the most valuable or interesting Animal, Bird, or Fish, in sufficient numbers to establish the breed. The decision to rest with the Council of the Acclimatisation Society, subject to the ratification of the Editor of *The Argus*. Application to be lodged with the Council of the Acclimatisation Society, before the 1st of December, 1862."

Zoology.—

9. *Uprising of the Seventeen-year Cicada, in New Haven County, Conn., in June*, 1860.—In June, 1843, swarms of the *Cicada septendecim*, Linn. (commonly called here the *Seventeen-year Locust*,) appeared in various places in New Haven County, Connecticut. Large numbers of this insect were then found in the bushes and trees on the eastern slope of West Rock, in the town of Hamden, about three miles N.N.W. from Yale College. On visiting this locality June 15, 1843, I found the insects active and noisy, and a record of my observations was made at the time. Seventeen years afterward, in the middle of June, 1860, I found this insect coming up in great numbers in and about the same spot, and one of the inhabitants of the vicinity assured me that the insect had not been seen there since 1843. The hoarse croaking noise made by an encampment of these insects can be heard a mile off, so that it is easy to detect them. In 1843 Judge Noyes Darling, who had spent most of his life near this place, told me that he could personally testify to an upcoming of this locust hereabouts in 1826, 1809 and 1792, and Rev. Jeremiah Day recently informed me that he had observed four of these periods here, viz: in 1809, 1826, 1843 and 1860.

It is remarkable that this insect, which exists but a few weeks in the perfect state above ground, should live nearly the whole of so long a life

in the earth as larva and pupa, and that in spite of varying weather, exposure and local causes, it should observe its seventeen-year period with such precision. It is also remarkable that in the United States there should be so many different districts each having its 17-year period of differing dates. It would seem much more probable that in any one place varying circumstances would hasten or retard the development of the insect, so that some individuals might be found there every year. To a very limited extent this may perhaps be the fact.

The locust-district to which New Haven County belongs extends from the Connecticut river westward to the Hudson river, and into New Jersey. That part of our State which lies east of Connecticut river has a different period. On the 22d of June, 1835, while travelling through Tolland County, Conn., in a stage coach, I passed through woods swarming with this Cicada. A map of the United States colored so as to show these different locust-districts would be of great interest to entomologists.

This insect is supposed to be peculiar to North America, and was made known to European naturalists by Peter Kalm of Sweden (*Kongl. Vetensk. Acad. Handl.* 1756), who travelled in Pennsylvania, New York, Canada, &c., in 1748 and 1749, and mentions an uprising of the Cicada about Philadelphia, Penn., in May, 1749, (*Travels, trans. by Forster, Lond.* 1772, 8°, 1 : 316, 2 : 62).

Very good accounts of this insect may be found in Prof. Nathaniel Potter's *Notes on the Locusta Septentrionalis Americanæ decem septima:* (Balt. 1839, 8vo, pp. 27, with plate;) and in Dr. T. W. Harris's Treatise on *Insects injurious to Vegetation*, (8vo. Bost., 1842, 1852, 1862).

New Haven, Conn., April 15, 1862. E. C. Herrick.

10. Thaddeus Wm. Harris, M.D. *A Treatise on some of the Insects injurious to Vegetation. A new edition, enlarged and improved, with additions from the Author's manuscripts, and original notes, and illustrated by engravings drawn from nature under the supervision of Prof.* Louis Agassiz. *Edited by* Charles L. Flint, *Secretary of the Massachusetts State Board of Agriculture.* Boston, 1862, 8vo, pp. xi and 640. With 8 engraved steel plates comprising 96 figures, besides 278 figures in wood. —The first edition of this excellent work of the late Dr. Harris of Cambridge, was published in 1841 (8vo. pp. 467) by the Legislature of the State of Massachusetts, as one of the Scientific Reports prepared at the public expense, a small issue of the same with slight changes being also printed for sale (Bost., 1842, 8vo, pp. 459). An enlarged edition of the same was published in 1852, (Bost., 1852, 8vo, pp. 521). These editions were without drawings of the insects described, and although the great merits of the work were from the first universally acknowledged, the want of illustrations lessened its usefulness. In 1859 the Legislature of Massachusetts directed Mr. Flint to prepare a new, enlarged and illustrated edition of Dr. Harris's work. Mr. Flint, availing himself of some of the best aid he could procure in this country, has executed his commission in a highly creditable manner; and the result is a beautiful and valuable volume of great practical usefulness to the horticulturist and the farmer. It is enriched by a large addition to the chapter on the butterflies from the author's own manuscripts, and by important notes contributed by Dr. John L. Leconte, Philip R. Uhler, Esq., Dr. John G.

Morris, Edward Norton, Esq., and Baron R. Osten Sacken. In this enterprise the State has expended over ten thousand dollars for 2500 copies for their own distribution. Besides this issue, the work appears in three other editions, one of 500 copies for the benefit of the family of Dr. Harris, in superb style on tinted paper with the steel plates colored, at $5 per copy, and two cheaper editions, at $3.50 and $2.50 each. It deserves to find an extensive sale.

A few of the insects described still lack illustrations, among which may be mentioned the *Angoumois grain moth* (p. 499)—the *Eurytoma Hordei* (553)—the *Cecidomyia culmicola* (582)—and the *wheat midge* (592), which at this time is one of our most destructive insects. In the cases of the *Aegeria exitiosa*, and the *Cecidomyia destructor*, a drawing of the female would have been more useful.

It would add much to the convenience of reference to give on the steel plates, under or near each figure, the Latin or English name of the insect represented, or at least the page of the book where the description may be found. H.

III. ASTRONOMY.

1. *Rediscovery of the Asteroid Calypso* (53).—The Asteroid Calypso (53) was discovered by Dr. Luther at Bilk, April 4, 1858. It appeared as a star of the eleventh magnitude, and continued to be observed at Berlin until the 17th of June. At the opposition in 1859 this asteroid was no where seen; and again at the opposition in 1860 it escaped detection, so that there was reason to apprehend that this body, like Daphne, was entirely lost. Dr. Luther therefore prepared an ephemeris from the most reliable elements, and after three weeks of laborious search, discovered on the 27th of January, 1862, a small planet, distant about one degree from the place computed for Calypso. Unfavorable weather prevented further observations until Feb. 6th, when he found it again, and proved that it was indeed Calypso. This planet has since been observed at several other observatories.

2. *Name for Asteroid* (59).—Asteroid (59) was discovered by Mr. Chacornac at the Observatory of Paris, on the 12th of September, 1860. According to established usage, it devolved upon Mr. Chacornac, or upon Mr. LeVerrier, the Director of the Observatory, to select a name for this planet. But LeVerrier declined giving this planet a name, on the ground that he wished to introduce a new nomenclature of the group of planets between Mars and Jupiter: and he suggested that without continuing to give each planet a particular name, it would be a sufficient distinction to mention the number in order of discovery, attaching thereto the name of the discoverer. Mr. J. R. Hind of London, to whom we owe the discovery of ten of these bodies, took decided ground against the proposed innovation, as leading inevitably to confusion and useless trouble; ultimately causing a return, by general consent, to our present nomenclature. The same ground was taken by Mr. Goldschmidt to whom we owe fourteen of these planets; and by Dr. Luther who has discovered eleven. The Astronomer Royal of England, Sir John Herschel, and Prof. Argelander, as well as astronomers very generally throughout Europe, also pronounced against the proposed innovation. After waiting for more than a year from the time of discovery, Dr. Weiss of the Vienna Obser-

vatory, who had taken particular charge of the observations of this planet, requested Prof. von Littrow, Director of the Vienna Observatory, to give the planet a name. Prof. von Littrow chose the name *Elpis*, in allusion to the political condition of Europe at the time of its discovery. This name was immediately accepted by the German astronomers. At length in January, 1862, Prof. LeVerrier announced that he no longer refused to allow Mr. Chacornac to select a name for this planet. Mr. Chacornac then requested Mr. Hind to assign a name, and Mr. Hind selected the name *Olympia*. This name has been accepted by the English astronomers, and will probably be universally adopted.

3. *Discovery of Asteroid* (73).—On the 8th of April, 1862, a planet of the 13th magnitude was discovered near the star Beta Virginis, by Mr. H. P. Tuttle of the Cambridge (Mass.) Observatory. It is the third which has been detected at this Observatory within the past year.

The name *Feronia* has been selected by Mr. Safford and Dr. Peters for the asteroid (72).

4. *Letter from the eminent astronomer, J. R. Hind of London, announcing the disappearance of a nebula.*—"Towards the close of the past year, it was announced by Prof. d'Arrest, of Copenhagen, that a nebula in the constellation Taurus, which was discovered at this observatory on the 11th of October, 1852, had totally vanished from its place in the heavens. That one of these objects, which the giant telescopes of the present day had taught us to regard as assemblages of stars in myriads at immense distances from the earth, should suddenly fade away, so as to be quite imperceptible in powerful instruments, must, I think, have been deemed a very improbable occurrence, even by many who are well acquainted with the care and experience of the observer by whom the statement was made. Within the last few days, however, Mr. LeVerrier has obtained so strong a confirmation of its accuracy, that there is no longer room for supposing it to have originated in one of those errors of observation which every practical astronomer knows will creep into his work in spite of all his precautions.

The nebula in question was situated in right ascension $4^h\ 13^m\ 54{\cdot}6$sec., and north declination $19^\circ\ 11'\ 37''$, for the beginning of 1862. It was therefore about a degree and a half from the star Epsilon in Taurus, in the group commonly known as "the Hyades." Its diameter was about one minute of an arc, with a condensation of light in the centre; or its appearance was that of a distant globular cluster, when viewed in telescopes of insufficient power to resolve it into stars. From 1852 to 1856 a star of the 10th magnitude almost touched the edge of the nebula at its north-following edge; it was first remarked on the night the nebula was detected, having escaped notice on many occasions when its position had been under examination with the same telescope and powers. Hence I was induced to hint at its probable variability in a note upon the nebula published in No. 839 of the *Astronomische Nachrichten*. The suspicion is fully confirmed; the star has diminished to the twelfth magnitude, either simultaneously with, or soon after, the apparent extinction of the nebula.

The history of this object and the results of his observations on the night of January 26, are appended by Mr. LeVerrier to his Meteorological Bulletin of the 29th. The sky being very clear at intervals, the

Paris equatorial, which has an object-glass 12 French inches in diameter, was directed to the place of the nebula, but, notwithstanding stars of an extremely faint class were visible in its immediate neighborhood, not the slightest trace of it could be perceived either by M. LeVerrier or M. Chacornac. The star which Professor d'Arrest and I have repeatedly noted, of the tenth magnitude, and almost touching the nebula, had dwindled down to the twelfth; so that telescopes which would have shown it well between 1852 and 1856, would not at present afford a glimpse of it. From the fact that M. Chacornac saw the nebula in forming a chart of the stars in that region in 1854, and did not remark it while reconstructing the same in 1858 with a much more powerful instrument, there is reason to infer that the disappearance took place during 1856, or the following year.

How the variability of the nebula and a star closely adjacent is to be explained, it is not easy to say in the actual state of our knowledge of the constitution of the sidereal universe. A dense but invisible body of immense extent interposing between the earth and them might produce effects which would accord with those observed; yet it appears more natural to conclude that there is some intimate connexion between the star and the nebula, upon which alternations of visibility and invisibility of the latter may depend. If it be allowable to suppose that a nebula can shine by light reflected from a star, then the waning of the latter might account for apparent extinction of the former; but in this case it is hardly possible to conceive that the nebula can have a stellar constitution.

It is at least curious that several variable stars have been detected in the region of the great nebula in Orion; that in 1860 a star suddenly shone out in the middle of the well-known nebula Messier 80 (about half-way between Antares and Beta in Scorpio) which vanished in a few days; and that, as first remarked by Sir John Herschel, all the temporary stars, without exception, having been situate in or near to the borders of the Milky Way—the star-cluster or ring to which our system of sun and planets belongs. In the latter class are included the memorable star of B. C. 134, which led Hipparchus to form his catalogue of stars, and those which blazed forth in 1572 and 1604, in the times of Tycho Brahe and Kepler.

In concluding, I will venture to express the hope that some of the many amateur astronomers in this country who have provided themselves with telescopes of first-rate excellence, will keep a strict watch upon the remarkable pair of variables which I have briefly described in this communication. Continuity of observation is often most important, and can only be secured—and that not always in the uncertainty of weather—by a strong force of observers in different localities.

I am, Sir, your most obedient servant,

J. R. Hind.

Mr. Bishop's Observatory, Regent's Park, Feb. 3.

P. S. Since writing the above, I have received a letter from Professor Secchi, the able and energetic director of the Observatory of the Collegio Romano at Rome, by which it appears that in one of the proverbially clear skies of that city, and with the large telescope at his command, he was unable on the 27th ult., to discern the least vestige of the nebula."

IV. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

From our Paris Correspondent.

1. *The Artesian Well at Passy.*—The complete success of the Artesian well at Passy has given lively satisfaction to all, and especially to those who appreciate the scientific interest which attaches to it. The question of water is of itself interesting enough to the Parisian people who have been reduced hitherto to the Seine as the principal source of potable water. The Prefect of the Seine had conceived a project for an aqueduct to be fed by the numerous springs in the neighborhood of Châlons sur Marne. It seems quite remarkable that this project was little to the public taste and that numerous voices were raised in favor of the river Seine! The Parisians are convinced that this river water is excellent; I will not affirm the contrary, but I am often struck with the complaints of strangers who generally charge upon this water the indispositions to which they are exposed during a visit in Paris. On the other hand I cannot maintain that in the long run an aqueduct is not the most economical provision for water for those who are prepared to meet the first cost. The example of Rome, which has been thus supplied even to the present day by the aqueducts of the Cæsars, proves this beyond dispute:—what would have been the expense during two thousand years of raising the water of the Tiber to a suitable height, if the Romans had been reduced to this method?

The city of Paris while awaiting the adoption of more thorough measures for attaining her water supply, has achieved an experiment which has given an excellent result, resolving several important questions and opening new ones. The first and most important question is to know if the water in a well of large dimensions will preserve an ascensional force sufficient to furnish a quantity of water proportioned to its increased diameter. Assuming that the water in the Passy well should rise with an abundance equal to that in the well of Grenelle, it ought to furnish near 40,000 cubic meters in 24 hours. (The cubic meter =220·17 gallons). Mr. Kind, the German engineer, the inventor of the method used in boring this well, and charged with the execution of the work, contracted to guarantee only 13,300 cubic meters, and on this estimate the plan was adopted. The boring commenced in September, 1854, and was finished on the 24th of September, 1861. The flow has remarkably exceeded the estimates—commencing slowly at first, on the 27th of last September it had reached 25,000 cubic meters and finally rested at 20,000 c. m. This yield, it is to be remembered, was found constant only at the well's mouth, and diminished very considerably when the tubes were added which carried it up to 25 meters above the ground. The well of Grenelle which yielded 2000 litres per minute at the surface, gave only 630 litres, less than one third, at the summit of a tube rising 33 metres above the level of the surface.

The second question is, what will be the influence of the new well upon the old, distant from it about 3000 metres (less than two miles). The latter soon commenced to show a diminished flow, and by the 1st of October the diminution had reached a fourth of the ordinary yield, falling from 630 to 460 litres per minute, a loss of about 40,000 gallons in

24 hours. The hope now is that there will be an increase again in the flow at Grenelle when the water of the Passy well by being raised considerably above the level of the earth shall again reëstablish the pressure. It appears impossible to foresee what may be the final result of this operation. Mr. Kind's method of boring perfectly met what was intended and the well had reached at the end of two years and three months 528 meters in depth, when a crush in the upper part seriously retarded the progress of the work. It required almost three years to repair this accident, and the total cost estimated by Mr. Kind at 350 thousand francs will reach near a million.

The water sheet is pierced 23 metres lower down than at the well of Grenelle—the latter being 547 metres absolute depth, and 511 m. below sea level; the well at Passy the orifice of which is $16^{m}{\cdot}5$ higher has an actual depth of 588 m. or 533 m. beneath sea level. The temperature of the water is the same in both wells $=28°$ C. or $82°{\cdot}4$ Fh.

It is easy to see that the third question—what advantage is it to make a new experiment of the same kind?—leaves an ample field for discussion. [We would say on this point that the experience of California has been decidedly adverse to the multiplication of Artesian wells, in the same hydrographical basin.—Eds.]

Dumas has given in the *Comptes Rendus* of the French Academy, (T. 53, p. 571) an interesting memoir in detail on this subject, from which most of the facts here presented are drawn.

2. *The Geological Society of France.*—This Society held its last annual reunion in Sept., 1861, at St.-Jean-de-Maurienne in Savoy, a province lately added to France. About sixty members were present at the meeting. The principal topic of discussion was the question which for thirty years has been controverted and sustained by Elie de Beaumont, viz: whether in the western Alps there exists an inversion, or a mixture, of the fauna and flora of the Lias with those of the Carboniferous formation. It is to be regretted that no one was present to sustain the thesis of the leading geologist of France, and still more that in so numerous a society there was no one to enter adequately into the detail of Alpine stratigraphy, a subject sufficiently difficult. The members were conducted over the ground of observation by Messrs Lory, Alf. Favre, the Abbé Chamoasset and Mr. Pillet.*

[The points of observation and argument are very nearly the same which have already been stated in detail in the review by Mr. Hunt of Prof. Favre's memoir on the structure of the Alps in vol. xxix, p. 118 of this Journal.—Eds.]

The number of the Bulletin of the Society containing the official notice of this meeting by the Secretaries is now in press.

3. *The Tunnel of Mt. Cenis.*—Your readers will find more interest probably in a notice of observations made during a recent visit to the famous Tunnel now in progress through Mt. Cenis, already more than once noticed in these pages.

This tunnel, the execution of which has been assumed by the Italian government, presents peculiar difficulties, especially because it is impossi-

* Prof. Favre has given a brief account of the observations made on this occasion in the Bib. Univ. de Geneve, Oct. 1861.

ble, owing to the enormous superincumbent mountain mass, to operate at more than two places. The mountain rises to the height of one thousand to fifteen hundred metres (3280 to 5000 feet, nearly) above the level of the gallery.

It was requisite from the first to find means to render the work as active as possible and employ machines for boring the blast holes. The little machine which moves the drills is ingeniously constructed but offers no difficulty to a mechanician. The percussion and rotation of the drill rod is accomplished by the power of compressed air which also injects a stream of water into the blast hole. In the trial made before the Geological Society of France which was conducted in one of the work shops of the company the drill entered a huge block of marble at the rate of 50 centimeters in 10 to 15 minutes, (about 1½ inches per minute). The feature of the process which interested us most was the production of the motive power. It is accomplished by an ingenious application of the hydraulic ram so much used in the United States, and set up here on a gigantic scale. The use of steam power presented great difficulties in a tunnel, each half of which when near its end will be over six kilometers long (=3¾ miles). They could not think of setting up boilers in the tunnel itself, since it was plain there would be serious difficulties in ventilation, and the attempt to conduct steam to so great a distance by pipes, would involve the loss of a great part of the power. By replacing steam with compressed air they enjoyed the double advantage of an economical application of the power at a distance from its source, and the use of the escaping air to renew the air of the tunnel. On the Italian side at Bardonèche, the air pumps are set up at about a kilometer from the opening of the tunnel, and they will act toward the last through nearly two leagues distance. The column of water which compresses the air in the chamber of the hydraulic ram is 25 metres high by 60 centimetres in diameter, the compression of air in the reservoir of the ram at the moment of fall is six atmospheres—at this instant a valve yielding at five atmospheres opens and a part of the compressed air escapes into immense boiler-like reservoirs. Five or six of these apparatus are needed for the regular progress of the work in the tunnel. The inventor of this remarkable apparatus, Mr. Tommelier, is director of the works. It is impossible to conceive any thing better adapted for a mountainous country where water is abundant. The apparatus appeared to us simple enough in its essential parts, which permitted the use of adequate solidity in the rest to resist the formidable shock with which it is shaken at short intervals. If the construction of these machines and the boring leaves little to desire it is by no means so sure that the perforation of the tunnel can be accelerated as much as would be presumed. They have perfected the rapidity of drilling, but the great labor of removing the rubbish is not accomplished more quickly than before. At the outset the engineers estimated six years, and to-day it seems probable that 12 years will be required to finish the tunnel if no unforeseen obstacles arise in the work.

4. *Spectroscope of Bunsen—Spectrology.*—The attention of the French scientific world is wholly fixed on *spectrology*, for thus do they designate the experiment with the spectroscope of Bunsen and Kirchhof. Mr. Grandeau, the pupil and fellow laborer of St. Clare Deville, has the merit

of having first initiated us into these beautiful researches, which he studied at Heidelberg whence he brought the first spectroscope seen in action in Paris. Since then it has become all the rage at Paris, and recently Mr. Jacmin has exhibited before a numerous auditory a large apparatus by Duboscq which projects the spectrum on a screen.

Mr. Grandeau has had the satisfaction of discovering the new metals, Cæsium and Rubidium, in the thermal waters of Bourbonne-les-Bains in larger quantities than in the waters examined by Bunsen. We might at first suppose that the discovery of new elements would be multiplied like those of the planets by a method at once so simple and certain. It does not appear at present however that this idea is likely to be realized. It is not sufficient, as seemed at first to be supposed, to expose a substance in the flame of the spectroscope to see defined there traces of all the elements it contains, while for those elements which like Cæsium and Rubidium exist in very minute quantity, it will always be found needful to separate first the larger part of the associated substances.

5. *The death of Biot*, is a great sorrow to all the friends of science. You have not wanted for biographical notices of this great savant. Permit me only to say what is on the lips of all:—that Biot is the most beautiful type known of what a scientist ought to be. He was wholly given up to science, and even to the last moment of his long life he was at its head. Three Academies of the *Institute* counted him among their members to prove that he belonged not alone to the physical sciences. But he was never any thing but the Professor and the Academician: he never subjected himself to the distractions of his illustrious cotemporary, Arago. Cuvier resembled him, with the advantage perhaps due to his vast erudition, and the clearness of his conceptions, but Cuvier did not see himself like Biot without a trace of the danger arising from the honors of high official station. Cuvier was made a baron, a peer of the realm, grand master of the University, and it is well known that he sometimes struggled against the power of jealousy.

6. *The two new Professors in the Garden of Plants.*—Messrs. Daubrée and d'Archiac opened their courses in the second week of March. Both the opening discourses resembled each other—first came an eulogy on their predecessors, followed by a profession of faith on their own part, and a programme of the courses they were commencing. These opening discourses, prepared with great care, drew together large audiences who rarely failed to find there matter for their legitimate applause.

Mr. Daubrée gave a masterly sketch of the history of geology, tracing its origin chiefly to the philosophers, Descartes and Leibnitz. He commenced his course, properly so-called, by the description of volcanic phenomena, and announced a complete exposition of Metamorphism, which will be taught now for the first time in the Garden of Plants. L. S.

Paris, April, 1862.

7. *Letter from Prof. Henry on the distribution of specimens in Natural History by the Smithsonian Institution.* (To the Editors of the American Journal of Science.)—GENTLEMEN:—In the letter of your Paris correspondent, published on page 149 of the January number of the Journal of Science for 1862, it is stated under the head of the Civic Museum of Milan, that the British Museum, and the Smithsonian Insti-

tution, were almost the only establishments that had not contributed materials towards the great work on serpents by Prof. Jan. As far as the Smithsonian Institution is concerned, this is an error, as its specimens have been freely at Prof. Jan's command. As full a series of North American serpents as could be supplied, amounting to about one hundred species was sent to him several years ago, and many additional species were transmitted last spring, leaving, according to Prof. Baird, but little to be desired as relates to North America. Indeed without the aid of the Smithsonian Institution, the species of serpents found in Texas, California, and other American localities, would have been inaccessible to Prof. Jan.

In this connection it may be stated that in the disposition of its undescribed materials, the Smithsonian Institution is governed solely by the desire to place them in the hands of naturalists best fitted to elaborate them without regard to individuals or country, and that it does not wait for an application, but itself makes the offer of the specimens. In addition to the free use by the best American naturalists, of such collections as they may need, its large series of Cephalopoda is now in the hands of Dr. Steenstrup of Copenhagen; its west coast shells is in the process of being described by Mr. P. P. Carpenter; its Polyzoa by Mr. Busk; its Hong Kong plants by Mr. Bentham, while types of the many new species described from its cabinet, amounting to more than ten thousand species and twenty thousand specimens, have been presented to most of the principal museums of the world.

I am, very respectfully your obed't servant,

JOSEPH HENRY, *Secretary S. I.*

Smithsonian Institution, Washington, Mar. 15, 1862.

8. *Ascent of Monte Rosa in Switzerland, September 4th*, 1861; by Rev. KINSLEY TWINING. (Extract from a private letter furnished by request to the Editors of this Journal.)— . . . . . But you are wondering, I presume, how we, who were lately on the other side of the mountains, have come into Italy. Our last was from Visp, where we were waiting for the cooler hours of the afternoon, and expecting then to go to St. Niklaus and thence to Zermatt. We carried out our plan successfully, and reached the inn on the Riffelberg Tuesday afternoon about 3 P. M. On the way we were joined by a young American from Boston who has travelled very largely. He had a desire equally strong with my own of climbing that terror of the Alps, Monte Rosa. Several ascents had been made this summer before we arrived. At Zermatt we saw three London young men who had made the attempt and gave it up only eight hundred or one thousand feet short of the summit, and we thought, after looking them over pretty carefully, that we were good for one thousand feet more than they. At the inn on the Riffelberg we met a young man who had achieved the ascent, and who told us so much about it that we determined to make the attempt the very next day if the weather should permit. We were fortunate in getting three of the very best Zermatt guides, and went to rest with our arrangements made and waiting to see what solution of the problem of the skies the morning would give.

Without describing what took place in those hours of delay, I still wish to interrupt my narrative at this point with an episode about Monte

Rosa. The great Italian mountain, in the estimate of most persons, is Mont Blanc of course. But Lord Byron never saw Monte Rosa, and though it is only a few feet lower than its great rival of Chamouni it never had any hymns sung in its praise till a few years ago. Indeed it had never been ascended to the very summit until the year 1855. I have read in some of the books on Monte Rosa that when De Saussure, that intrepid explorer of the Alps, was at Zermatt, he was unable to persuade the guide to ascend the last two peaks of this mountain and was compelled to abandon the attempt. The way up was at last found (as I think has been true in the case of nearly all the more difficult Alpine summits) not by a guide, but by a company of English travellers. I say the way was found by them, but this is not quite correct; for many persons before them had stood at the bottom of the Zumstein Spitze, eight hundred feet below the summit, and seen a way up which they had not the courage to attempt; and after having myself passed up that tremendous pathway of ice, I am perfectly convinced that, were the way untrodden, and could not the traveller be assured by knowing that others had found it practicable, he would turn away content at having surveyed the steps which lead to the inaccessible summit. This at least was the fate of every one who went alone to that spot and attempted to get higher,—and the Höchste Spitze, as it is called, was never made until six or seven persons, Englishmen and their guides, went to work together, and (tied together with a rope so that if one fell the others could save him) pushed along slowly and bravely to the very top. There they saw a grander view than Mont Blanc affords; and, though none of the difficulties of the ascent have been removed, a number of persons have followed them, each succeeding year, to the same grand height.

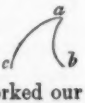
Murray, in comparing this with Mont Blanc, says there is no difficulty in the latter, and, comparing it with the ascent of Rigi—a mountain as difficult as Mount Washington—calls the latter a pleasant promenade. It may be so in the comparison, (and I think it is,) but in fact I can say, after walking up it, that to go up Rigi, even, is quite a trying thing in a hot day. But, difficult as Monte Rosa is, all who have made the ascent have agreed that the world has no other point of view to equal it. I will not now describe the scene which there opens to the eye, but merely say—what more than one Englishman has said to me after having ascended both Mont Blanc and Monte Rosa—"there is nothing to be seen from Mont Blanc, and it is foolish to make the ascent when Rosa is practicable."

To return from this digression: we were to start at 3 A. M. if the morning promised good weather. But at three the skies were doubtful, and we did not get off till a quarter of five. An Englishman who had himself made the ascent walked with us to the Görner glacier to enjoy the sunrise over Monte Rosa and the Lys Kamm,—which was indeed indescribably beautiful. The soft tint of morning fell upon the spotless snow and lay there till it brightened into the splendor of day. Behind us, at the end of the valley which contains the Görner glacier, and closing the view in that direction, rose the colossal stony pyramid of Monte Cervino, so steep that no snow adheres to its sides. Its inaccessible summit, four thousand feet above the snow from which it seems to rise, and nearly fifteen thou-

sand feet above the sea, caught also the first rays of morning and stood up in its many-colored magnificence, the only reminiscence among its snowy sisters of a world not covered with the glacier. One hour and ten minutes from the hotel brought us to the ice of the Görner glacier; forty minutes more took us across to the moraine on the other side, where the guides laid away a bottle of wine for the descent, and permitted us to take a drink of cold water. One hour more, up an icy hill about as steep as the lawn in front of the Hillhouse place, with deep crevasses opening on every side, brought us to our breakfast ground—a mass of broken rock, rising out of the glacier, and named "Auf der Platte." Here the guides brought out their stores of hard boiled eggs, bread, cheese, meat and wine. When these were eaten, or rather when as much was done in that direction as Kronig (the Grand Mogul of Monte Rosa) thought fit, the bags were shut, we were placed in line, and the rope (that signal that the time for hard work had come) was got out and all hands tied together in a line. King Kronig went first with his ice axe, to cut steps and hold on with the beak on the back of the axe; I next, three feet behind him; next Anton Rytz, a famous guide, with his face in a mask of checked cotton, who shouted "vorwärts" whenever Kronig cried "courage;" next came my friend Mr. ——, and last of all Franz Blatter, who sang "Ranz des vaches" all the way up, and who, if not strong enough to lift Monte Rosa itself, was abundantly able to carry any ordinary man to the top of it. Thus arranged we soon began to climb up the glacier, already quite steep (about 12°),—up, up, up, and ever up we went slowly and looking sharp where we stepped. First the surface was much like any ice that has been snowed upon and frozen again. Then we came into loose snow, three or four inches deep, which in its nature was a sort of compromise between hail and crystals. The path wound around from one ascent to another like a great serpent trailing between rounded hills of snow; what at one moment seemed like the crest of the ascent soon turned out the base of another, and where we discovered a level plain we were not permitted to go.

At first we walked a half hour together and then stopped for breath; but before long Kronig complained that we stopped every fifteen minutes; and after a while he declared that if we had our way it would be fifteen minutes walking and fifteen minutes on our backs on the snow—and then it would be all up for the Höchste Spitze. In the midst of these dismal forebodings I heard a heavy fall and the call of the guides behind, "attendez." I looked around. Blatter was rushing furiously down hill—for what, did not appear. But I soon saw that Mr. —— had fallen down exhausted and let his alpenstock go where he himself would have gone had not the strong arms of Tony Rytz been on him, and a good twist of the rope around him. His face was pale, his lips blue, and Kronig whispered to me in German, that it was impossible for him to reach the summit. However he rallied and went on very well. After three hours of such painful drudgery we reached the foot of the Signal Kuppe, where the guides took off their knapsacks—all hands had some new refreshment for the last great labor—the rope was doubled around us—and then Kronig set out ahead, cutting zig-zags in the fearful dome of ice we had to climb. In the earlier part of the morning I had looked

around a good deal on the scenery; but as we went higher and the labor became greater, I could not afford to throw away strength enough to look around; and now in this spot my horizon was restricted to the three feet square which lay under my eyes. After a long time of zigzagging up and back, around a dome of ice so steep that it would be impossible to stand on it anywhere without having places cut for the feet, we surmounted the Signal Kuppe dome, and stood at the base of the peak of terror—the Zumstein—where, even now, fully one-half of the few who come to it turn back. Here we looked back upon the ice wall we had edged around, step by step, putting our toes in holes cut in the ice, and saw that though it was at an angle of nearly forty-five degrees it was nothing in comparison to the eight hundred feet which remained. There were still two peaks above us which rose like crests one behind the other and in the same line—sharp, like a hatchet, and accessible only over what may be called the *blade* of ice which formed the ridge. It is a fact that the path here was a scant foot in width,—on the right was an abrupt precipice three or four thousand feet in depth,—on the left an almost equally steep declivity. Up this comb of ice Kronig cut steps and shouted "courage" with stirring drum-like voice, while Blatter, every few minutes, sang "Ranz des vaches" for our amusement. The excitement of such an ascent and of the scene around and before was so great that I felt no fatigue, and marched up as easily as if it were over a stairway. After proceeding thus some twenty minutes, I learned by accident the meaning of something which had been unintelligible to me in descriptions I had heard of this part of the ascent. It happened that, in striking my alpenstock into the ice for a good hold, it seemed once to go through; and when I drew it up to see what was the matter, there was a little round hole punched through the ice under my feet, through which I could look down several thousand feet along the face of a greenish-blue icy precipice. If I did not comprehend at the moment the full meaning of this observation, I did an instant later, when I came upon a larger hole through which I could see at leisure how the mountain was constructed, and in particular what sort of support our path had. The case, as I understand it, is that this ice has filled in the hollow between one peak and the other, and while it is banked out in a steep declivity toward the north, on the south it is built up straight above the precipitous rocks, and even overhangs them, as is often the case in a drift of snow. Hence it happens that the only place possible for an ascent is the icy path overhanging the tremendous gulf I have described. We went up without any slip against a boisterous wind, and after a hard struggle with the rocks reached the bottom of the Höchste Spitze. A section through the middle of the Zumstein Spitze would give some such diagram as this: *a b* being the south face of the precipice, *a c* the rounded or banked up glacier on the north, and *a* the place of the path up the edge of the crest. On reaching the summit of the Zumstein we rested on the warm side of the rocks, then worked our way down a hard descent of fifty feet, and there found ourselves at the bottom of the Höchste Spitze. It is more steep than the Zumstein, but not as dangerous; for the path lies back two or three feet from the edge of the snow and ice. When this crest was surmounted we stood on the



Höchste Spitze, but not on its highest point. These mountains are a kind of slate which breaks up easily into large and small blocks; and where the summit is a thin blade of stone, like Monte Rosa, it is not one piece of rock, but more like a wall loosely put together and broken down. I fancy that once this whole peak was one narrow wall of rock, eight or ten rods long, running east and west, and highest toward the east. The action of frost and weather and other natural forces broke it up into blocks, and in the process of time cut a breach through the middle, leaving it as we found it, a double or forked peak with the shorter tine first, or toward the west.

To give some idea of the difficulty of crossing this little gap and actually getting upon the opposite and highest point, I will say that, although it is not thirty feet deep nor twenty feet broad, still the two German brothers Schlagintweit, who were certainly brave men and most intrepid explorers, and who had nerve enough to mount, first of all who have attempted it, on to the lower tine of the summit, gave up the other. It was not the muscular exertion which deterred them, nor the time likely to be occupied in crossing the gap; for I passed straight through it at a burst, and was on the topmost point in two or three minutes afterwards. But it must have been the dreadful unknown task of venturing out over that airy walk and on to that apparently unsupported summit, where no previous foot had been, and whose accessibility they could not prove beforehand and could scarcely believe when looking upon it. It was a far different thing for us to do. I knew that the path was firm and that we could all sit on the summit, though only one at a time could mount the sharp point which caps it. I knew that there was no great labor in the undertaking, and no danger if my head was steady and my courage good. All this made it a perfectly easy thing for me to do, and I so forgot both difficulty and danger and the descent, that the hour we spent on that stony point, 15,223 feet above the sea, was one of the most delightful in all my life. Around us on every side were great mountains sunk down beneath their snows, like abashed virgins drooping in reverence; north, east and west, a panorama of majestic mountains lay around us. The dark needle of the Finster Aarhorn rose out of the snows of the great glacier of the Aar,—Schreckhorn, Wetterhorn, Titlis, the Eiger, and the Sidelhorn stood around it like an ancient brotherhood of giants. The Bernese Alps drew out their line in equal beauty and majesty from the Angelhörner and the Wetterhorn till it seemed to run up into the skies from the Silberhorn and the Jungfrau. Nearly due west lay the immense mass of Mont Blanc, white and glistening,—the one summit over which the eye could not range. The space between was filled with whatever of lake or mountain, of valley, field or barren, moor there is in Switzerland—lonely snowy points rising one above the other—dark black-ribbed glaciers rolling into the valleys—here a dome of snow capping the mountain with a biscuit-like cover of the purest white—while, all around the broken edges, blue avalanches were ready to drop into the grey and hazy depths beneath them. Southward, the eye looked through a bright blue sky into Italy,—first over the Pennine Alps, resting for a moment with admiration upon that most grand and pleasing object, the Becca di Nona: then in swift flight it passed from the thousand peaks and vales of Piedmont to Lago

Como and Maggiore,—and thence ran straight out into the plains of Lombardy and Venetia. How can I ever describe what my eyes saw in this view. I stood there drinking it in with delight—I knew not how long. I bade myself remember this and remember that; but, now, what can I recall. Becca di Nona is a distinct form in my mind, but beside this all is a formless procession of beautiful images—a delightful memory of evanescent things whose shape I do not know that I ever saw, and with respect to which I am certainly unable to say at this moment of what they consist. I remember a light falling down upon Italy, blue, soft, and yet so distinct and clear that all I saw against the sky had an edge—but it was an edge of velvet. I remember how my eye, accustomed to the altitudes of the Alps, at first refused to rest upon the blue plains of Italy, but adjusted itself to them as clouds in the air, till at length after something like a struggle it took the right focus, and falling down to the level of the sea, made me conscious of my own great elevation.

It is impossible to describe the light which illuminated the Italian view. It was a substance—as it seemed—and a color; and yet it was soft and clear. It glowed without being hazy, and gave everything with great distinctness without letting the eye into the deformities of the country, or displaying the formless and less pleasing secrets of the landscape, as the midday sun of Switzerland does. The guides said that in perfect weather the spires of the cathedral at Milan are visible, and that the eye can reach nearly as far as Venice. There were clouds on our horizon, and some of the valleys were filled with their billowy masses. The wind tossed them about like balloons, and as they rose and fell and tumbled about on the unstable support of the air (as it seemed to be), and as at times they dissolved or broke apart, we had lovely views of the country below.

My companion reached the summit a few minutes after I did, but immediately fell asleep and could not be roused till a few minutes before we left the top. I really did not observe how he came up the Zumstein or the crest of the Höchste Spitze, but I well remember seeing him lying flat on the lower tine of the summit, whence the guides steadied and lifted him up till he was on the top; when he did precisely what Albert Smith did on Mont Blanc, i. e., went to sleep. I made a number of observations upon myself, and could not see that the great altitude changed my bodily condition in any way. I was not sick at the stomach at all—my breath was neither shorter nor deeper as I could perceive—my head was not at all infirm. Hearing was equally good, as I can testify after having been bothered with Blatter's incessant "Ranz des vaches." The air filled my lungs as it does elsewhere, and from observing myself I could detect none of those signs of a great altitude which other persons have felt on the summits of such high mountains. On Faulhorn, and at other times when I have been on high mountains, I have noticed the darkness of the sky, and was prepared to find the vault of a deep and almost blackish blue on Rosa. But in this I was disappointed; and I do not know to what I am to attribute its ordinary appearance unless to the slight haze which, as it were, detained the eye in an illuminated atmosphere, and prevented it from looking into the thin, clear and rayless space which so many observers have described as the dark vault seen from the summits of high mountains. I have an indistinct recollection of having felt cold, and am

certain that the guides said they were, and that it would not do to remain longer in such a wind. What the temperature was I do not know, although there was a minimum thermometer there which had been placed by the Alpine Club. But I could not make out anything from it because the indicating fluid was perfectly colorless and seemed to have faded out, so that it was impossible to see where the column stood. At last we commenced the descent, at 1 o'clock P. M.; but first I went up the pinnacle once more and waved my adieus from it to the silent world of majesty and beauty which in an hour of time had given me so much pleasure. In the silence of those solitudes my voice was lost,—nothing that we could do seemed able to disturb it. The wind, which blew in tremendous gusts and then subsided, was the only sound which filled those spaces, except when the avalanche (of which there were many during our ascent) added its thunder to the roar of the tempest, or sliding down amid the silent snows grew into a sound which waved through the air and made the mountains tremble.

But this is not the descent. I confess I was more nervous about going down than I had been at any time in going up. One hour was consumed in the first eight hundred feet—then soon after we came to the dome up which our zigzags ran and which we had climbed so slowly in the morning with our faces to the wall and our toes in holes in the ice—edging our way along, a step at a time. Soon we saw, below, the knapsacks of the guides where they left them, with the bottle of champagne and other refreshments they had brought up and deposited there where the labor and danger of the ascent both begin and end,—to celebrate with them our victory, when we had come once more into safe places. Four hundred or five hundred feet above this spot the leading guide, John Kronig, sat down on the snow; and while I was wondering what was to happen, Mr. —— was got into place behind him, his feet put forward under the guide's arms,—then the second guide followed. I instinctively took my place, supposing it would be quite right, but rather hoping we were not going to slide down that tremendous declivity at the risk of our pantaloons. However, the sun, which was cold on the top, was warmer here, and the loose snow was soft to a depth of three or four inches, and the guides meant to improve it; so when all was ready Blatter sat down behind me, and off went the five like a kind of human sled. The guides' alpenstocks, managed by their strong and skillful arms, kept us in line, and, I suppose, lessened the speed somewhat. But they had, after all, so little power against the force of gravity that we shot down like an arrow and ploughed into the snow opposite our camp—all wanting to laugh and shout, but utterly without the breath required in such exercises.

When we were on our feet again the lunch came out and we had a merry time in consuming it. The guides danced and rolled about on the snow, and sang rattling French songs with a perfect *abandon*, as if delighted to have come down Monte Rosa once more alive. We were still a great way from the hotel—not less than eighteen miles. The guides said it could not be done in less than three hours, and we made up our minds to see if we could accomplish it in that time. The rope which had been taken off at lunch came out again, and we were all tied

together once more in a line:—and now the problem was to slide down in one hour the glacier which had cost us five in the morning. We stood up straight, and steered with our alpenstocks; the strong arms of the guides served for rudders, stays and breaks; and down we went at a tremendous speed. Do not think, however, it was mere sport. My legs would now and then tremble under the exertion to keep them in place, my breath would give out, and after fifteen minutes of such rapid descent we would have to lie down and get ready to try it again. The steep places were passed sled-wise. The ladies had gone up to the top of Görner Grat about 1 o'clock, P. M., to watch our progress, and there, beside having one of the finest views in Switzerland to enjoy, had the full sight of our novel method of descent. Some gentlemen were with them who had made the ascent themselves and were able to show them where to point their glass in order to find the exceedingly small black specks they were looking for. At last these were discovered refreshing themselves at the bottom of the dangerous peaks, and then sliding down hill at an unheard of rate; and finally they disappeared among the rocks in the moraine of the glacier, when they were lost for the time, and not again seen till they appeared at the hotel, some two hours from the place.—I believe the distance up and down is rated at forty miles. We were absent from the hotel thirteen hours and a quarter; of which three hours and a half were consumed in the halt on the summit and those for breakfast and the other lunches up and down.

9. *Geological and Mineralogical Museum at Rochester, N. Y.*—Having lately enjoyed an opportunity of inspecting the collection of fossils, rocks and minerals formed by Prof. Henry A. Ward, of Rochester, a short notice of it will be acceptable as marking the steady progress making in the appreciation of scientific objects in the United States. This collection has been amassed by the personal exertions and zeal of Prof. Ward during six years passed by him in all parts of Europe, in Asia, Africa and America, he having travelled over 100,000 miles in his visits to localities and collections. It has been formed from the first on a plan designed to illustrate the departments of geology and mineralogy to students. This plan contemplated the representation of every genus of fossil organism hitherto described, as well as a complete lithological and mineralogical collection. Happily for science, Prof. Ward's plans found a liberal patron in the noble liberality of the Hon. LEVI WARD, a wealthy citizen of Rochester, who advanced the funds required for the purpose to an extent of nearly twenty thousand dollars. These collections are temporarily arranged in a large hall (80 by 120 feet and 20 feet high) in Rochester, with several smaller rooms attached. The general effect is magnificent and imposing. On first entering the Hall, the eye is arrested by the gigantic head of the Deinotherium (cast) and other huge forms of fossil life, by the long ranges of polished marbles, Septaria, Ammonites, &c., which although not yet systematically arranged in detail, are conspicuous objects in the *coup d'œil*. It is difficult from statistical statements to form any adequate impression of such a collection. A few figures will however assist in a comparison.

The Minerals are arranged according to Dana's last edition: 5,200 specimens are conspicuously placed on isolated blocks and nicely labelled.

The Rocks (numbering 3000 specimens) are classified according to mineral composition independent of structure or geological position—a strictly lithological collection. The individual pieces are large, well formed, and whenever needed to show structure or economical value, polished blocks of the same rocks stand beside their rough associates. A complete series of Cordier's species of rocks labelled by himself is merged in this lithological collection. In examining this collection one is constantly struck with the number of authentic specimens collected by Prof. Ward from the localities where specific rocks were first described, e. g., Syenites from Syena, Dolomite from Fassathal, Palagonite from Palagonia, &c.

In addition to the lithological collection is another of some 700 specimens arranged statigraphically and designed to precede the fossils in each geological formation. Of special collections we noticed a beautiful suite of 350 polished blocks of Italian marbles and ornamental stones selected and arranged by Prof. Meneghini of Pisa: a series of 180 Tuscan rocks; of 100 from Monte Bolca; 120 from the Paris Basin; 80 from Saxony; 60 from Lake Superior; and 200 from Central France. There is also a superior special collection from Mt. Vesuvius, selected from d'Archiac's cabinet. Thus the total of rock specimens reaches about 5000, each well mounted and labelled. The whole is arranged on the system of Cordier, with whom Prof. Ward was a diligent student.

It is difficult to form an estimate of the extent and value of a Palæontological collection by a statement of numerical quantities. It is probably safe to state that Prof. Ward's collection contains 8,000 distinct species of fossils from European localities represented by 25,000 specimens, besides the collection of fossils from American localities. Some of the genera we noticed as particularly rich in species. Thus there are about 540 species of *Ammonites*, 100 species of *Echinoderms*, 150 species of *Trilobites*. When completely arranged it is believed that this collection will require about 40,000 labels.

Unique specimens are represented by casts in which Prof. Ward's collection is peculiarly rich, embracing, if the *Trilobites* and *Foraminiferæ* are included, over 200 genera.

Thus the famous Mosasaurus Hoffmanni from the Garden of Plants, Cuvier's Maestricht specimen, never before allowed to be copied, is now available to American collections: Prof. Ward having the moulds for reproducing this and a large number of other celebrated and unique specimens, like the head of Deinotherium. We have received the following note from Prof. Hitchcock in reference to the cast of Deinotherium which has been recently added to the Museum at Amherst, as well as to Prof. Ward's collection.

From Prof. E. Hitchcock, Senior.

"A fine plaster cast of the head of a Deinotherium of the natural size, has just been added to the cabinet of Amherst College. As this is the first cast of this unique specimen ever prepared in this country, I have thought that you might like a brief notice of it. It was executed in Rochester, N. Y., under the direction of Prof. Henry A. Ward, of the University in that place, from a copy recently received by him from Germany, and is done very skillfully and perfectly. It makes a very strong impression on the beholder. One sees that this animal must have been the largest of all terrestrial quadrupeds yet discovered, if indeed it was such, and that the power of the curved tusks in his lower

jaw, must have been enormous in grubbing up roots. The huge nasal fossæ are, also, apparently, a striking proof of the existence in the living animal of a huge proboscis, such as is usually figured. Pictet and others, as you know, place this animal among the Sirenoids.

Mr. Ward expects to receive and to copy, also, in a few weeks, a cast of the femur of the Deinotherium, five feet long, as well as some other bones; and a head reduced in size. The cost of the cast which we have received, with a platform and irons for mounting, is *one hundred and twenty dollars*, and it has been presented to the College by myself and Ephraim Brown, Esq., of Lowell.

I do not remember to have seen in your Journal any description of the splendid cabinet which Professor Ward has collected, now on exhibition in Rochester. By incredible industry, and visiting almost every important locality in Europe, and many in Asia and Africa, as well as in this country, and expending much money, he has brought together a geological cabinet unequalled as a whole in the United States; also a very large collection of simple minerals. It might well satisfy an octogenarian naturalist as his life work; but Prof. Ward, I understand, is not yet thirty. It will well repay the scientific man for turning aside a good distance to visit it.

Neither do I remember to have seen it any where stated in print, that Prof. Ward has had copied in plaster almost all the large and rare geological specimens in the cabinets of Europe, which are sold in such establishments as those of Krantz at Bonn. These are fully equal in execution to those from Bonn, and considerably cheaper, to say nothing of transportation.

I am very glad that Prof. Ward is able and willing to superintend this work, which will be of so great service to the literary institutions of our country. He will soon be able to furnish casts of 200 genera, great and small. I have obtained as many of them as my means would allow, and have seen most of them, and know that they are very satisfactory. I hope Prof. Ward will soon publish a catalogue, with prices, of such as his moulders can furnish."

We understand that an effort is on foot to secure this fine museum for the city of Rochester. It is an object well worthy of the ambition of any city to obtain such a noble and permanent institution, free at all times to the public. The power of such a collection is immense in raising the public taste to an enlightened standard, proving that there are other objects worth attention besides those which minister to sensuous pleasure. It is justly esteemed as an evidence of a refined and cultivated community when collections of art and museums of natural history are established and opened at the public expense. The citizens of Rochester, if they secure the permanent establishment of the Ward Museum in their city, may well pride themselves on the acquisition: they will hold the most extensive geological museum in the United States and secure the presence of students in geology and mineralogy, who will come up to Rochester to avail themselves of the educational advantages connected with this museum, and the lectures of Prof. Ward, who now holds the chair of natural science in the University of Rochester.

10. *Fossil larvæ in the Connecticut River Sandstone.*—One of the most interesting objects described and figured in the great work of Prof. Hitchcock on the footprints of the Connecticut River sandstone is the larva of a Neuropterous insect. In a recent letter, Dr. John L. Leconte has given the following opinion respecting the relations of the species:

"The animal figured on p. 8 of Ichnology of Massachusetts, appears to me to resemble most a larva of a Neuropterous insect belonging to the family *Ephemeridae*. The projections each side look to me like the branchiæ proceeding from the abdominal segments as seen in the larvæ of Ephemera."

Prof. Hitchcock has expressed his desire to the writer, in view of the above opinion, that the name of the species be changed to *Palephemera mediæva.* J. D. DANA.

11. *On the Geology and Natural History of the Upper Missouri;* being the substance of a report made to Lieut. G. K. WARREN, T.E., U.S.A., by Dr. F. V. HAYDEN, Surgeon and Geologist of the expedition to the Upper Missouri and Yellow Stone, under the command of Lieut. Warren. 228 pages, 4to, with a Geological Map. From the Transactions of the American Philosophical Society.—It being probable, from circumstances beyond control, that the publication of Lieut. Warren's final report would be long delayed, permission was obtained to abstract such parts of the Geology and Natural History portions as were deemed desirable for publication in a connected form. These constitute a report of progress rather than a complete work on that portion of the West. The contents of the memoir are as follows:

Historical Introduction.

Part I.—Descriptive geology of the routes.
- Chapter 1.—Exploration of Platte River Valley from Bellevue to the mouth of Elkhorn river.
- Chapter 2.—From Bellevue to the Big Sioux river.
- " 3.—From Omaha City to Fort Laramie.
- " 4.—Geology in the vicinity of Fort Laramie.
- " 5.—Fort Laramie to the Black Hills.
- " 6.—From Bear Peak to Fort Randall on the Missouri river.

Part II.—General geology of the country.
- Chapter 7.—Granite, Stratified Azoic, and Eruptive rocks.
- " 8.—Potsdam Sandstone, (Lower Silurian).
- " 9.—Carboniferous and Permian periods.
- " 10.—Jurassic System.
- " 11.—Tertiary Basins of the Upper Missouri.
- " 12.—Quaternary deposits.
- " 13.—Resumé of the Geology of the Missouri river and its tributaries.
- " 14.—Catalogue of Minerals and Geological specimens.

Part III.—Zoology and Botany.
- Chapter 15.—Catalogue of Minerals with notes on their habits and distribution, 48 species.
- Chapter 16.—Catalogue of Birds with notes on their geographical distribution, 256 species.
- Chapter 17.—Catalogue of Reptiles, Fishes and recent shells. Reptiles, 33 species; Fishes, 25 species; Recent Mollusca, 65 species.
- Chapter 18.—Catalogue of recent plants. Phænogamous plants, 726 species; Carices, 56 species.

Dr. Hayden is a devoted worker in several departments of investigation not usually united in one person. He is now engaged upon some ethnographical and philological researches related to the aboriginal tribes among whom he has resided. Some of the results of these studies we hope to present to our readers in an early number.

12. *Sixth Annual Report of the Secretary of the Maine Board of Agriculture;* embracing also the Reports on the Scientific Survey, 1861. Augusta: Stevens & Sayward, Printers to the State. 8vo, pp. 464.—The larger portion of this volume is devoted to the "Preliminary Report upon the Natural History and Geology of the State of Maine," under the direction of EZEKIEL HOLMES, of Winthrop, *Naturalist*, and CHARLES H. HITCHCOCK, of Amherst, Mass., *Geologist*, assisted by GEO. L. GOODALE,

of Saco, *Botanist* and *Chemist*, J. C. Houghton, of Still River, Mass., *Mineralogist*, A. S. Packard, Jr., of Brunswick, *Entomologist*, and C. B. Fuller, of Portland, *Marine Zoologist*.

We must defer to a subsequent issue a notice of this Report, which embraces some points of general geology of great scientific interest: as for example, the proof that the lowest member of the Carboniferous system in New Brunswick overlies unconformably the equivalents of the Perry beds, establishing, in view of Mr. Hitchcock, the certainty that the Carboniferous system does not occur in Maine.

It is worthy of remark that, in these times of civil strife, Maine has the courage to inaugurate a new scientific survey, while some other States are suspending work on surveys only partly completed. This is the more to the honor of Maine, inasmuch as in case of a foreign war she would be the first to suffer the liability of invasion.

13. *Report on the Geological Survey of the State of Wisconsin*, Vol. I.; by James Hall on General Geology and Palæontology, and J. D. Whitney on the Upper Mississippi Lead Region. Printed by authority of the Legislature of Wisconsin, January, 1862. Large 8vo, pp. 455.—This very valuable volume contains a chapter in 72 pages on the Physical Geography and General Geology of the State of Wisconsin, by Prof. Hall, followed by a Report on the Lead Region, filling 350 pages in five chapters by Prof. Whitney. This report is of the highest economic and general interest, presenting the whole subject of the lead region in its historical, physical, geological, mineralogical and mining relations in a methodical and exhaustive style, leaving nothing to desire. The report is concluded by some observations on the mammalian remains found in the lead crevices by Profs. Leidy and Wyman; and the last chapter contains a catalogue of fossils, with remarks and descriptions of some new ones by Prof. Hall. We shall revert to this report again in more detail. It is admirably well printed and illustrated. The beautiful maps, diagrams and sections by Prof. Whitney of the lead region deserve especial mention.

14. Obituary.—*Hiram A. Prout, M.D.* died at St. Louis, Mo., April 21, 1862. Dr. Prout was well known as a naturalist and a zealous member of the St. Louis Academy of Science. Our geological readers will recall his description, in March, 1847, (this Jour., iii, 248) of a fossil maxillary bone of Palæotherium from near White River in the Mauvaise Terres. This was our first definite knowledge of that vast mausoleum of Palæotherial remains, since become so famous. He was an eminent physician and most useful citizen.

K. C. v. Leonhard.—Died on the 23d of January, 1862, at Heidelberg, K. C. v. Leonhard, Prof. of Mineralogy in that city since 1818. He was born in Rumpenheim near Hanau, Sept. 12, 1779. Among his numerous writings the following deserve mention:

Handbuch einer allgemeinen topographischen Mineralogie. 3 Bde. Frankfort, 1809.—Characteristik der Felsarten. Heidelberg, 1823.—Handbuch der Oryktognosie. Heidelberg, 1826. 2 Aufl.—Die Basalt Gebilde. 2 Bde. Stuttgart, 1832. —Grundzüge der Oryktognosie. Heidelberg, 1833. 2 Aufl.—Agenda geognostica. Heidelberg, 1838. 2 Aufl.—Grundzüge der Geologie und Geognosie. Heidelberg, 1839. 3 Aufl.—Geologie oder Naturgeschichte der Erde. 5 Bde. Stuttgart, 1836–1844.—Lehrbuch der Geognosie und Geologie. Stuttgart, 1849. 2 Aufl.

Taschenbuch für die gesammte Mineralogie. Frankfort, 1807–1824.—Zeitschrift für Mineralogie. Frankfort, 1825–1829.—Jahrbuch für Mineralogie etc. von K. C. v. Leonhard und H. G. Bronn. Stuttgart, 1830–1862.

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